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PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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The Soil and Water Conservation Research Division works in cooperation with the State Agricultural Experiment Stations.

CONTENTS

IRRIGATION

Montana

IMPROVED IRRIGATION PRACTICES INCREASE HAY YIELDS

Sterling Davis, Chinook. --The combination of improved irrigation practices and heavy nitrogen fertilization gave a tenfold increase in western wheatgrass hay yields (0.5 to 5.0 tons an acre). Mosquito production was eliminated in all of the intermittent irrigation treatments, but swarms of mosquitoes, including Culex tarsalis, the encephalitis carrier, were produced in the continuous flooding or "present practice" plots. The present irrigation practice in the western wheatgrass meadows on the clay soils of the Milk River Valley is to continuously flood each spring for 30 to 40 days.

These studies were conducted on the Bowdoin clay soils (83 percent clay) which have extremely low water intake rates. Cylinder infiltrometer tests show that after the initial filling of the large cracks the intake rate drops slowly and becomes negligible in about 30 hours. The water loss from the infiltrometer after 30 hours could be accounted for by evaporation. This is shown in the accompanying figure.

Since these clay soils crack readily as they dry out, the water intake rate has been found to be as much as 6 inches per hour for the first 10-minute period. During the growing season 3 to 4 inches of irrigation water was applied at about two-week intervals with no appreciable ponding and the elimination of "on-field" mosquito production. Under this irrigation practice excellent response to nitrogen application was obtained and high hay yields resulted. In the continuously flooded plots there were low hay yields and a poor response to nitrogen application. Thus, the combination of improved irrigation practices and heavy nitrogen fertilization were required to produce high yields of western wheatgrass hay.

These preliminary studies were started in the summer of 1955 and are now being expanded to include irrigation water management studies, soil management studies with other crops, and drainage investigations.

Utah

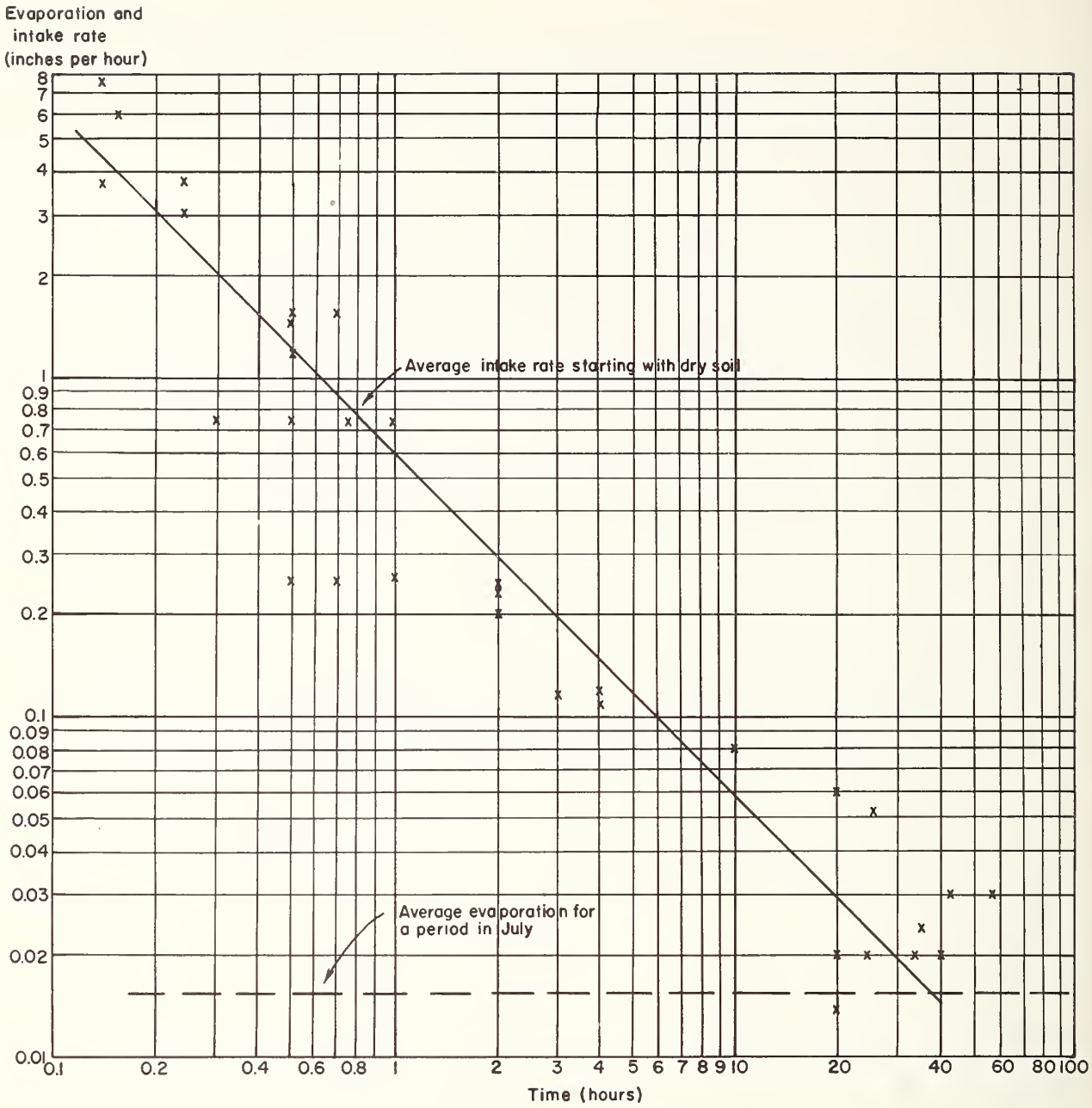
RESULTS WITH BUILT-UP ASPHALT LININGS ENCOURAGING

C. W. Lauritzen, Logan. --Built-up asphalt linings have been under test with encouraging results for over two years in the vicinity of Logan, Utah. Because of this, and to determine the adaptability of this lining to warmer areas, a test lining was constructed on the Wellton Mohawk Development Farm, Roll, Arizona, in cooperation with Dr. C. O. Stanberry and his associates.

The built-up asphaltic lining consists of alternate layers of asphalt and jute or other reinforcing material. The reinforcing used in the lining was a 10-ounce treated-burlap jute. It appears now that specifications and construction steps for such a lining should be about as follows:

1. Apply catalytically-blown asphalt--one gallon per square yard directly on the subgrade.

2. Place single layer of treated 10-ounce burlap jute over sprayed area.



Change in average water intake rate of Bowdoin clay soil with time as determined by cylinder infiltrometer tests, Chinook, Mont.

3. Apply catalytically-blown asphalt over the jute at the rate of 0.75 gallon per square yard.

4. Add another single layer of treated 10-ounce burlap jute.

5. Apply final layer of catalytically-blown asphalt.

The cost of installation was $0.72 per square yard for the two-ply lining and $0.48 for the one-ply lining. This includes cost of materials delivered at site and labor required in construction.

Nebraska

IRRIGATION AFFECTS CORN YIELD AND RESIDUAL NITROGEN

T. M. McCalla, F. L. Duley, R. E. Luebs, Lincoln.--On the Agronomy Farm after corn had matured, there was more available nitrogen as nitrates remaining in the 6-foot profile where no irrigation water had been used than where a pre-planting irrigation had been applied. More nitrogen remained in the profile where 120 pounds of nitrogen as ammonium nitrate had been applied than where none was used.

These results were obtained in 1956 in studies of the effect of stored moisture at planting and nitrogen fertilization on stubble-mulched corn. The yields obtained and nitrate nitrogen in the profile at maturity are shown in the accompanying table. Although rainfall in the growing season was only slightly below normal, yields were low on the plots without irrigation because of dry subsoil.

Corn yield and residual available nitrate nitrogen on stubble mulched plots as affected by pre-plant irrigation, Lincoln, Neb. Soil samples taken Nov. 8, 1956

Nitrate nitrogen by depths (Feet)										Yield per acre
							Average			
0-½	½-1	1-2	2-3	3-4	4-5	5-6	0-1	0-3	0-6	
ppm	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*Bushels*
Not irrigated, no nitrogen										
17.5	23.6	19.6	9.5	5.1	4.5	3.0	20.6	16.6	10.4	5.5
Not irrigated, Ammonium nitrate[1]										
41.4	76.6	26.5	5.8	4.6	5.9	5.3	59.0	30.4	17.9	1.7
Irrigated in spring to depth of 5 feet, no nitrogen										
14.9	7.6	8.7	6.9	5.5	5.9	5.5	11.3	9.0	7.3	71.1
Irrigated in spring to depth of 5 feet, Ammonium nitrate[1]										
17.2	20.7	11.0	12.4	6.5	5.4	6.4	19.0	14.1	10.1	82.2

[1] 120 pounds per acre of nitrogen as ammonium applied before planting.

DRAINAGE

Florida

BUSH BEANS WITHSTAND 36 HOURS CONTINUOUS SUBMERSION

John C. Stephens, Fort Lauderdale.--Preliminary tests on submersion damage to bush beans and sweet peppers were made in 1955. Potted plants, grown in sand, were immersed in water to a depth of about 1 inch above the soil surface for continuous 12-hour intervals ranging up to 72 hours. An appraisal of the damage to the plants was made 6 days after the last pots had been removed from the water. Root conditions gave a better indication of permanent injury than did foliage damage. A graph was plotted of submersion time versus injury for both beans and peppers and the plotted points showed

considerable scatter; however, the enveloping curve showed a definite breaking point between 36 and 48 hours thus indicating that for soils with rapid to very rapid internal drainage these plants could take up to 36 hours flooding with only slight damage.

Tests were extended to lysimeter tanks in 1956. Twelve tanks, each with an area of 0.001-acre, containing sandy soils typical for south Florida were planted to Black Valentine bush beans. During the summer months, prior to planting, the tanks were kept free of all plant growth and the water level held at a depth of 24 to 30 inches to allow the organic material in the soil to "burn-out" and lower the incidence of micro-organisms. The 12 tanks were planted during the last week in October and fertilized with 4-7-5 at the rate of 1,500 pounds per acre. During early stages of growth the water table was held at a depth of 18 inches to promote germination, and then lowered to 24 inches which earlier investigations proved to be optimum for growth of these plants.

Flooding began at 4:00 p.m. on November 18, when plants were at the early bloom stage. Flood stages were held for 12-, 24-, 36-, 48-, and 60-hour intervals. Tanks were divided into two groups of six tanks each because of a group variance in soil fertility, and pairs replicated for each stage of flooding. All tanks were lowered to the original 24-inch water table depth at 4:00 a.m. November 21, 1956.

Foliage inspection 48 hours after the tanks were drained showed the following symptoms of wilt: Checks and 12-hour flooding, no wilting; 24-hrs., very slight wilting; 36 hrs., slight wilting; 48 and 60 hrs., severe wilting. Approximately 96 hours after drainage several plants were removed from each tank and the condition of the root systems observed. It was noted that in most cases where the plants had been flooded, new lateral roots had emerged from the main stem above the old root system. This was not the case in the unflooded check tanks. In general, the following root conditions were noted: Checks, no root damage, no new root formation; 12-hr. flooding, slight root damage, medium new root formation; 24-hr. flooding, slight root damage, medium new root formation; 36 hr. flooding, medium root damage, medium to heavy new root formation; 48 hr. flooding, severe root damage, trace to medium new root formation; 60 hr. flooding, severe root damage, trace of new root formation.

Water tables were again maintained at the optimum depth of 24 inches until the plants reached maturity. Shortly after the flooding test, those plants subjected to inundation and not defoliated, greened up in comparison to the unflooded checks. At harvest, 3 pickings were made at intervals of about 10 days. The unflooded plants produced beans earlier and more uniformly than those flooded. It appeared that plant recovery and yields depended on original plant vigor and soil microbiological conditions, except in tanks flooded more than 36 hours, where there was little plant recovery regardless of growing conditions.

Effect of flooding time on yield of Black Valentine bush beans grown in 0.001-acre tanks, Fort Lauderdale, Fla., 1956

Submersion time	Yield of beans per tank			Beans per plant	
	Marketable	Cull	Total	Marketable	Total
Hours	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
0	5,233	1,020	6,253	25.9	30.9
12	7,125	1,055	8,180	45.3	52.1
24	3,108	409	3,517	36.2	40.9
36	6,019	541	6,560	40.6	44.3
48	307	83	390	3.9	4.9
60	391	58	449	4.2	4.8

It should be pointed out that these yields were obtained when the beans were flooded during a relatively cool period. Rainy, cloudy weather occurred during and for several days after submersion. Further, the plants were at the very early bloom rather than late bloom or early "pin" stage which many farmers believe is a more critical time for injury. Further tests are being made in an effort to secure additional information on these points.

Georgia

STUDY STARTED ON DRAINAGE REQUIREMENTS OF PINE SEEDLINGS

R. L. Green and L. C. Walker, Fleming.--Because of the increasing demand for pine-pulpwood, a small plot experiment has been initiated to study the effect of improved drainage on the survival and growth of slash and loblolly pine seedlings. These criteria will be correlated with various drainage coefficients and other basic data for woodland drainage systems. After results are obtained over a two- or three-year period, more extensive field experiments will be established.

Colorado

WATER TABLE LOWERED BY PUMPING FROM ARTESIAN AQUIFER

M. M. Hastings, N. A. Evans, M. Amemiya, C. W. Robinson, Grand Junction.--Reversal of upward hydraulic gradient by pumping from an artesian aquifer near Grand Junction, Colorado, was reported on page 20 of Quarterly Report No. 8. The possibility of leakage of water through discontinuities in the confining layer was also discussed.

After six months of nonpumping, the pump was again started in June 1956. At this time the piezometric surface was nearly steady and the water table had risen to a level less than six feet from the ground surface in the experimental area. Observations of water table depth were made within the area of influence following the initiation of pumping. The water table in part of the area of influence was definitely lowered during this summer period by the reduction in the aquifer pressure, even though the test was made during the peak of the irrigation season, when the water table would otherwise be rising. The accompanying figure shows the rate of recession for the first 60 days following the initiation of pumping. The recession rate during this period was greater than 0.03 feet per day over an area of about 185 acres. This accounts for lowering the water table at least two and as much as six feet from its nonpumped position on June 21.

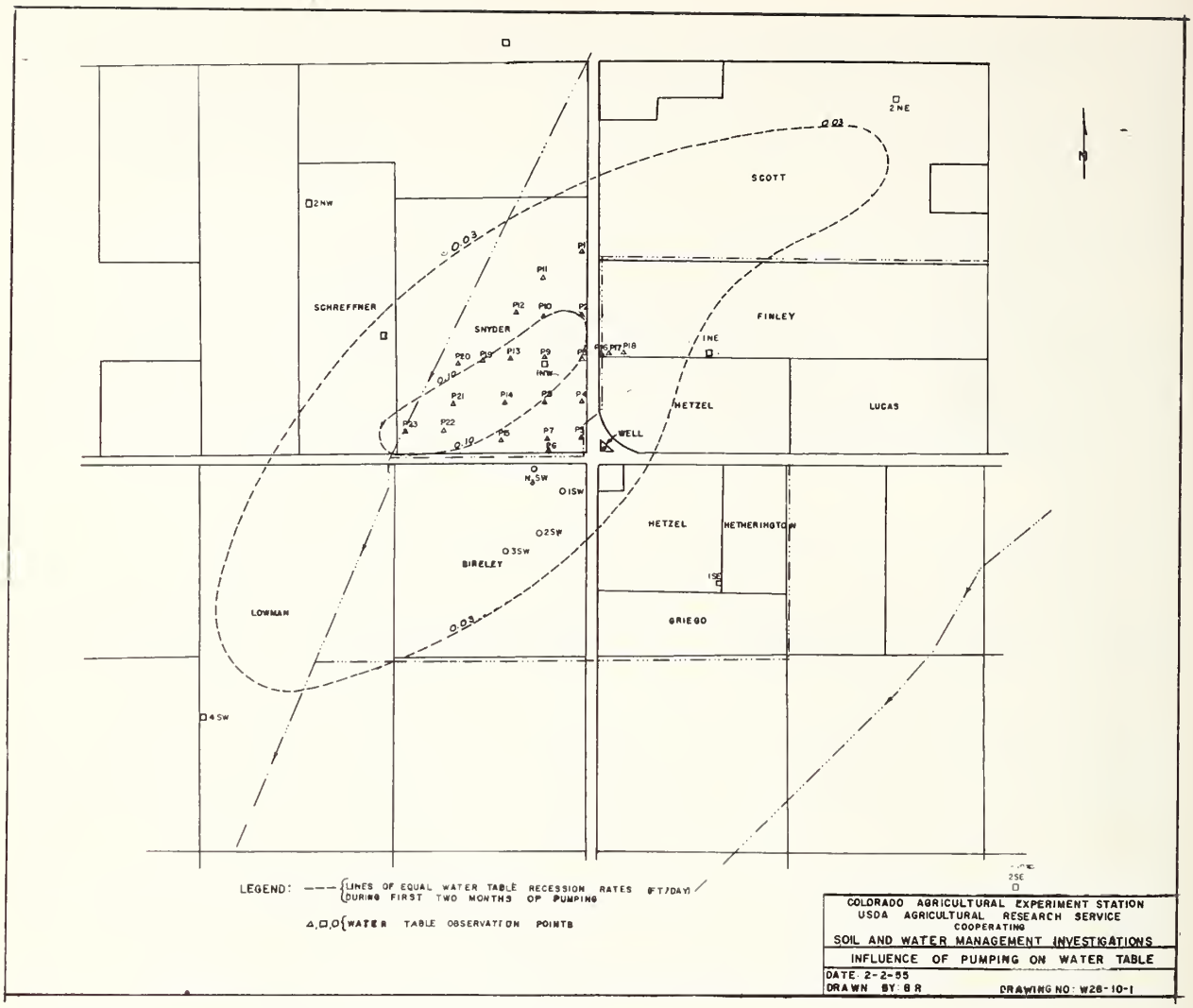
The area in which the recession rate was largest coincides with a discontinuity in the confining layer as mapped by stratum survey techniques. Lateral movement of water in the overburden toward this sink resulted in the lesser recession rate over a larger surrounding area.

California

BACTERIAL PRODUCTS CAN BE REMOVED FROM TILE

W. F. Spencer, A. J. MacKenzie, Brawley.--Two types of foreign deposits in the joints of farm drain tile in the Imperial Valley were found to be waste products of bacterial action. These can be effectively removed and the drainage lines restored to a satisfactorily functioning condition by dissolution with a suitable combination of chemicals costing from $3 to $5 per acre.

The Soil Conservation Service and other action agencies requested research assistance on the problem. Representatives of the Soil and Water Conservation Research Division, ARS, the University of California Agricultural Experiment Station, the Imperial Irrigation District, and the Soil Conservation Service formed a committee to plan and conduct work on the problem.



Chemical analysis of samples of the material from several tile lines showed that the red material was mainly ferric oxide whereas the black material was mainly manganese dioxide. Biological examination of the samples by James P. Martin of the University of California Citrus Experiment Station indicated that the red deposit consisted largely of excretion bands of typical iron bacteria of the Gallionella type. The black material also showed evidence of being a waste product of bacterial action. Evidently the iron bacteria oxidize iron or manganese as a source of energy and deposit the iron or manganese oxides inside the tile lines as waste products.

Laboratory investigations directed toward finding an economically suitable combination of chemicals to dissolve the materials indicated that a mixture of one-normal sulfuric acid and 2 percent sodium bisulfite would readily dissolve both the black and red material and that the cost of the chemicals in the desired concentrations would be between $3 and $5 per acre depending upon the size of tile and the design of the tile drainage system.

A field experiment was conducted to evaluate the effectiveness of the following three treatments in removing the material from a tile system: 1. Chemicals only, 2. brushing with a wire brush followed by chemical treatment, and 3. brushing only. The procedure for chemical treatment consists of filling the line with a solution of 1N sulfuric acid and 2 percent sodium bisulfite. This is accomplished by simultaneously introducing

sulfuric acid, water and a concentrated solution of sodium meta bisulfite in the desired ratio into the upper end of the tile line. The chemicals are allowed to remain in the tile for at least 24 hours after treatment.

Piezometer and water stage recorder data showed that the chemical treatment was definitely effective in improving drawdown by the tile lines. Brushing plus chemicals was not significantly better than chemicals alone, whereas, brushing alone did not appear to be effective in improving drainage. At this time it is not known how long the improved drainage effects of the chemicals will persist. It was noted that ferric oxide Gallionella excretion bands appeared at the outlet of the chemically treated lines approximately 6 weeks following treatment. However, the lines continue to function properly.

Cooperative research directed toward a more accurate evaluation of the immediate and lasting effects of the chemical treatment is in progress.

EROSION AND RUNOFF CONTROL

Kansas

STRIP WIDTH FOR EROSION CONTROL RELATED TO TEXTURE

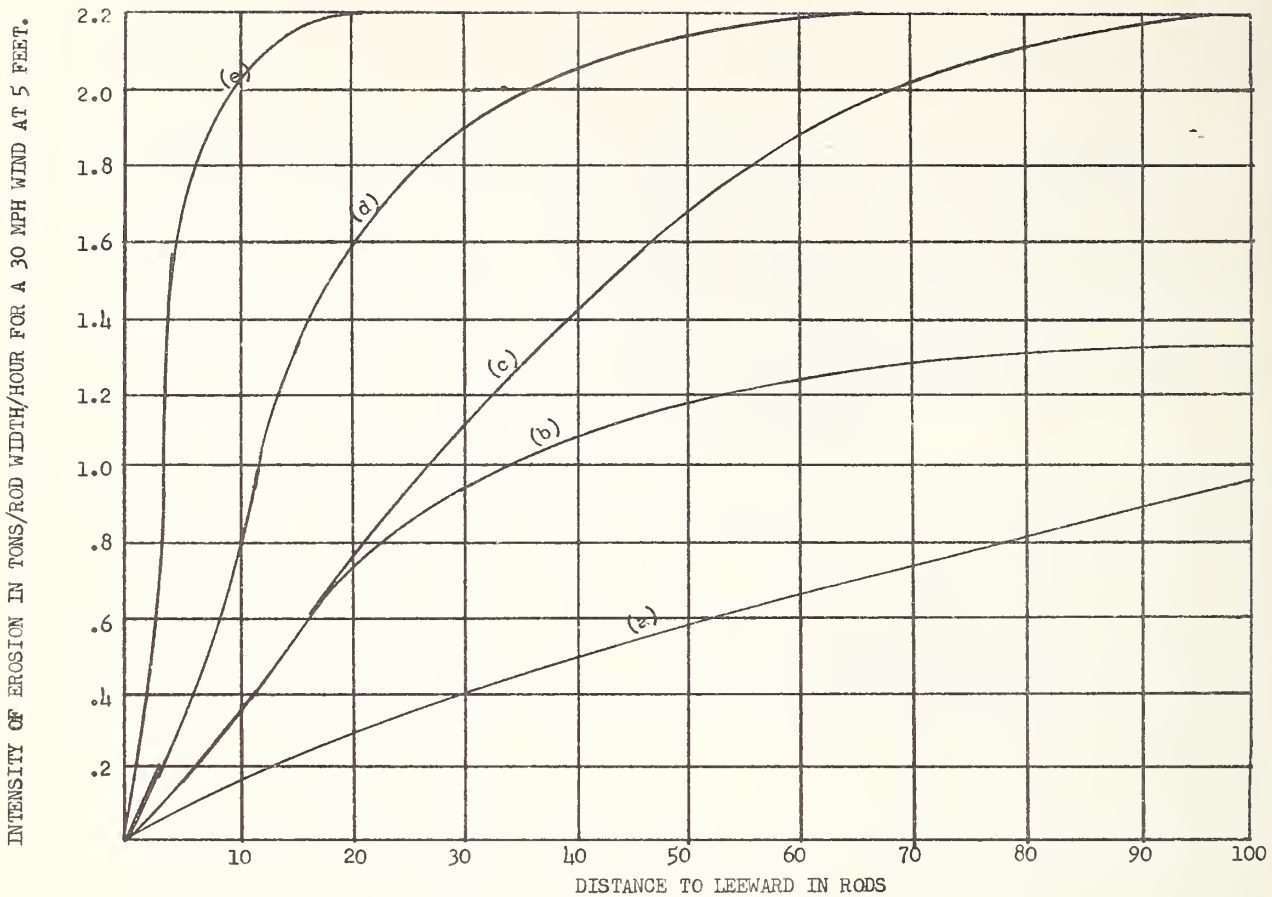
W. S. Chepil, Manhattan. --Recent measurements in Kansas showed that the rate of soil movement by wind began with virtual zero on the windward sides of isolated fields or strips and increased with distance downwind in some cases for almost half mile. The rate of increase varied directly with the amount of loose, erodible soil particles on the surface and with the susceptibility of clods and surface crust to disintegration by impacts of jumping soil particles. The rate of increase was associated indirectly with soil texture inasmuch as soil texture affected the proportion of erodible material and the susceptibility of the surface crust and clods to abrasion by jumping soil particles.

Average results from recent and all previous measurements on different soil textures are shown graphically in the accompanying figure. The rate of soil movement shown was adjusted to a wind velocity of 30 miles per hour at 5 feet. The adjustment is based on the relationship $E \propto U^5$ in which E is the intensity of erosion and U is velocity of the wind.

The rate of increase of erosion with distance downwind has a direct bearing on how wide erosion-susceptible strips should be to prevent erosion on the leeward side of strips from exceeding a negligible rate. This rate is probably 0.25 ton per rod width per hour. To prevent erosion from exceeding this negligible rate, the figure shows that the erosion-susceptible strips running at right angles to a 30 mph wind at 5 feet should not exceed a width of 18 rods on intermediate textured soils (loam, silt loam, clay loam, etc.), 8 rods on granulated clay and fine sandy loam, 4 rods on loamy fine sand, and about 1.5 rods on fine sand. Of course a base other than 0.25 ton can be used if desired. This base is presented only for illustration and not as a recommendation.

Apart from soil texture, there are other factors that enter into consideration of how wide strips should be. For instance, the concave curvature of the lower portions of curves (b), (c), (d), and (e) is due to sheltering effects of standing stubble on the windward of wind-erodible strips, but if the stubble is knocked down, as by tillage, the sheltering effects would be reduced or lost and narrower strips would be required for equal effectiveness.

Another factor that determines how wide strips should be is the general level of wind velocity. The more windy parts of the country would require narrower strips than the less windy. How much influence differences in wind velocity will have on intensity of erosion at any field location on any soil class can be computed from the relationship $E \propto U^5$. How much narrower or wider strips would need to be for equal effectiveness can be determined from the figure.



Relative intensity of erosion of soil by wind with distance to leeward on (a) intermediate textured soils (loam, silt loam, clay loam), (b) granulated clays, (c) fine sandy loam, (d) loamy fine sand, and (e) fine sand. The windward side is protected by standing wheat or sorghum stubble. Manhattan, Kans.

Still another factor that determines how wide strips should be is the direction of the strips with respect to the direction of the wind. The data presented are for strips running at right angles to the wind. If the prevailing wind blows across the strips at a 45 degree angle, as it often does in actual layouts, the width of strips would have to be reduced by 1.415 (diagonal of square in proportion to its side) of those running at right angles to the wind if they are to be equally effective.

Finally, and probably the most important factor that determines how wide the strips should be on different soil textures is the amount of crop residue anchored at the surface. The required width of strips varies in inverse proportion to the amount of crop residue. For example, if the amount of crop residue is doubled, soil erodibility and the effective width of strips are roughly reduced to half.

Conventional stripping always was found to reduce the intensity of erosion but not to stop it. The greater the soil erodibility and wind velocity the narrower the strips had to be for equal effectiveness. It is important therefore to supplement stripping with methods that reduce soil erodibility to the minimum.

Iowa

WIDER SPACING OF LEVEL TERRACES JUSTIFIED ON LOESS SOILS

W. E. Larson and F. W. Schaller, Ames.--Level terraces in western Iowa may be spaced wider than currently recommended provided the corn is contour listed. This was found in studies during the last 8 years at the Western Iowa Experiment Station, Castana. Furthermore, it appears that rotations with a greater percentage of corn than a corn-oats-meadow-meadow rotation can be used on slopes up to at least 12 percent if the corn is contour listed. It was found that under spacings 1-1/2 and 2 times normal as determined by the formula $\frac{S + 3}{2}$ terrace channel capacities decreased only about 10 percent during the study. Similar results were observed on the other terraced fields in the experiment. There was little, if any, terrace overtopping during severe runoff storms. Runoff from the terraced fields was neglible for most rainstorms.

An analysis of the 12 highest erosion producing storms showed that one storm had a 60-minute intensity of 2.84 inches per hour. A storm of this intensity would be expected once in 50 years. The remaining 11 storms had 60-minute intensities ranging from 0.77 to 1.56 inches per hour. These would be expected to occur at least once every two years.

Level terraces have proved to be very effective on the deep, permeable loess soil of Western Iowa. To supply the need for design information, level terraces with different spacings were compared at the experiment farm from 1949 to 1956. The spacings used were 1-1/4, 1-1/2, 1-3/4, and 2 times normal. The experiment was located on Ida and Monona silt loam soil with an average land slope of 12 to 14 percent. The fields were farmed in a 4-year rotation of corn-oats-meadow-meadow. The corn was always contour listed after plowing.

Results of measurements made on small plots at the Western Iowa Experimental Farm during the same period as the terrace spacing studies, showed that soil and water losses from corn were considerably lower under contour listing than under contour surface planting or up-and-down hill planting. Runoff never exceeded 0.88 inch in any 24-hour period during the 9 years of study with contour listing. The largest loss from contour surface planted corn was 1.58 inches. Soil losses in tons per acre per year during the 9-1 year period averaged 2.8 for contour listed corn, 8.9 for contour surface planted corn and 22.6 for corn planted up-and-down hill.

Mississippi

LITTLE TALLAHATCHIE WATERSHED STUDIES STARTED

Calvin K. Mutchler, State College.--As part of the research on the Little Tallahatchie Watershed, a study has been started to determine runoff and soil loss values under existing and improved methods of soil management on the North Mississippi Branch Experiment Station near Holly Springs. The plots and small watersheds comprising the study are on the Brown loam soils, the predominant soil of the Little Tallahatchie Watershed. Representatives of both the Eastern Soil and Water Management Section and Watershed Hydrology Section are participating in this work.

The following plots and watersheds are included in the study:

Land use	Management	Land slope[1]	Size[1]	No. of plots or watersheds
Cultivated-corn	Improved (cover crops, mulch fertilizer, etc.)	2-1/2 5 10 8	150'x72.6' 150'x72.6' 150'x72.6' 1-1/2 acre	2 plots 2 plots 2 plots 1 watershed
	Existing (poor)	5 10 10	150'x72.6' 1-1/2 acre 4 acres	2 plots 1 watershed 1 watershed
Pasture	Improved (sod seeding, fertilizer, etc.)	5 10	30'x72.6' 30'x72.6'	2 plots 2 plots
	Existing (No fertilizer, heavy grazing etc.)	5 10 8	30'x72.6' 30'x72.6' 3 acres	2 plots 2 plots 1 watershed

[1] Approximate.

Puerto Rico

EROSION CONTROLLED UNDER BANANAS ON STEEP SLOPES

Ruben R. Caro and Jose Vicente, Orocovis.--A method has been developed and tested experimentally for the production of high yielding bananas and plantains, a cooking banana, on steep slopes with good erosion control and low costs. The method consists of planting the plantains close together in 2-row hedges with a kudzu-molasses grass cover crop between hedges.

With a cover crop growing in close association with the plantains, soil losses on a 45 percent slope were only 7.4 tons per acre yearly in contrast to 95.5 tons per acre yearly with clean cultivation. With both methods, equally high yields were produced, about 20 tons of green plantains per acre, when ample fertility was provided. The kudzu-molasses grass in the strips was allowed to grow freely. Cultivation costs were thus reduced since only the area under the hedges required cultivation and the close growing bananas soon shaded out most of the weeds. Soon after the bananas were harvested, an excellent kudzu-molasses grass pasture was ready for grazing.

SOIL FERTILITY

Pennsylvania

ROOTING DEPTH UNAFFECTED BY SURFACE FERTILIZATION

W. V. Chandler, University Park.--The depth of rooting of oats and red clover was unaffected by 76 years of surface soil treatment as shown by results obtained in September 1956 on the Jordan Fertility Plots at Pennsylvania State University.

Five treatments in the unlimed tier of the Jordan Plots were sampled after the harvest of oats. At the time of sampling, all plots were in red clover. The treatments, average depth of rooting, and the ranges of depth of rooting are shown below:

Treatment*	Depth of rooting	
	Average	Range
	Inches	*Inches*
Check (nothing)..	28.8	24-34
PK.....	31.8	26-35
3N (SN) PK.....	28.2	26-31
3N (AS) PK.....	30.0	26-34
10T Manure.....	27.0	23-30

*N=24 lbs. N per acre sodium nitrate (SN) or ammonium sulfate (AS).
P=48 lbs. P_2O_5 per acre as superphosphate
K=100 lbs. K_2O per acre as muriate of potash.

There were no differences in depth of root penetration from the different surface soil fertilization practices. Oat and red clover roots did not readily penetrate the platy structural horizon at about 8 to 16 inches. There was a reduction in number of roots through this layer and those present generally followed structural faces.

Pennsylvania

EFFECTIVENESS OF PHOSPHATE INCREASED BY BANDING

R. R. Robinson, V. G. Sprague and C. F. Gross, University Park.--The results of experiments in controlled-temperature chambers in cooperation with the U. S. Regional Pasture Research Laboratory, indicate that band placement of phosphate fertilizers is especially effective at low temperatures. Red clover was grown at 50°, 60°, 70°, and 80°F with various amounts of phosphate fertilizer applied in two ways; (1) in bands 1 inch below the surface of the soil, and (2) mixed with the top 2-1/2 inches of soil.

Rate of growth of the clover seedlings varied widely depending upon temperature and rate placement of fertilizer. At very low levels of available phosphate, growth was most rapid at the higher temperatures, with the optimum between 70 and 80°F. With high levels of phosphate fertilization, optimum temperature for plant growth was between 60 and 70°F. These differences appear to be related to a more rapid rate of absorption of phosphorus at higher temperatures.

Good growth was obtained even at 50°F where the concentration of available phosphorus in the soil was increased to compensate for the lower rate of absorption at low temperature. Band placement was the most effective way of increasing phosphorus availability to the plant, particularly at low temperatures. At 50°F on the depleted soil, banded phosphate was 7 times as effective as when mixed with the soil, whereas at 80°F it was 3-1/2 times as effective. For example, at 50°F, plant growth was as good with 25 pounds P_2O_5 banded as with 175 pounds mixed with the soil.

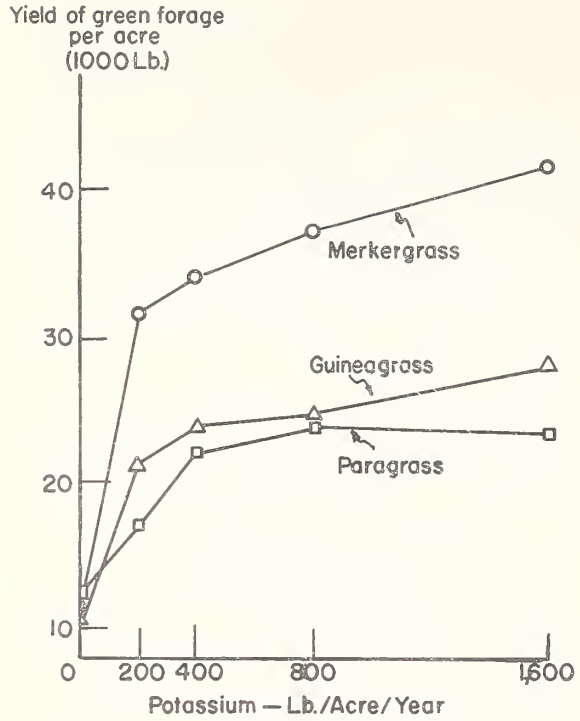
The results of these investigations indicate that band placement of phosphate would be particularly desirable for seedlings made during the cold weather of early spring in order to get the plants off to a good start.

Puerto Rico

TROPICAL GRASSES RESPOND TO POTASSIUM

Jose Vicente, Rio Piedras.--Merker, Guinea and Para grass growing on a deep, red, acid soil and receiving all other nutrients in abundance responded strongly to potassium fertilization in an experiment carried out at Rio Piedras.

One-thousand pounds of calcium and 400 pounds of P_2O_5 were applied per acre to all plots. Nitrogen was applied at the rate of 800 pounds per acre yearly. The grasses were cut every 60 days at which time one-sixth of the total annual application of potassium and nitrogen applied.



--The effect of fertilization with potassium on the yields of green forage produced by 3 grasses growing on a deep, red, acid Fajardo clay soil at Rio Piedras over a 2-month period. One-sixth of the total annual application of potassium was applied as potassium sulphate. All other fertilizer elements were supplied in abundance.
(1,000 pounds Ca, 400 pounds P_2O_5 and 800 pounds N per acre yearly.)

The accompanying figure shows the response of these grasses to fertilization with potassium over the first two months of experimentation. Yields of Merker grass were about tripled and those of Guinea grass about doubled by the application of potassium at the rate of 200 pounds per acre yearly. Yields of Para grass were about doubled by the application of potassium at the rate of 400 pounds per acre yearly. All grasses in the plots receiving no potassium exhibited the typical symptoms of a potassium deficiency, i. e., burning of the leaf tips and spotting of the older leaves, thin stalks, etc.,

Georgia

LIME NEEDED ON WESTON AND LEC T SOILS FOR SOYBEANS

A. E. Royer, Fleming. --The need for lime to grow soybeans on Leon fine sand and Weston fine sandy loam was shown in field experiments at Fleming.

The three treatments applied in the spring of 1956 and the yields of soybeans harvested in the fall of 1956 are shown in the accompanying table.

Influence of lime and fertilizer on soybean yields on Leon and Weston soils, Fleming, Georgia, 1956

Soil	Planting date	Yield of soybeans per acre			
		Treatment[1]			
		1	2	3	Mean
		Bushels	*Bushels*	*Bushels*	*Bushels*
WEston	7-10	7.0	6.8	16.6	10.1
	5-17	26.2	22.8	31.9	26.9
Mean		16.6	14.8	24.2	18.5
Leon	7-10	0.4	2.0	18.7	7.0
	5-17	0.0	0.1	12.7	4.3
Mean.....		0.2	1.0	15.7	5.6

[1] Treatment 1: 400 lbs. 4-12-12 in row.
Treatment 2: 400 lbs. 4-12-12 in row plus 400 lbs. 4-12-12 and minor elements broadcast.
Treatment 3: 400 lbs. 4-12-12 in row plus 400 lbs. 4-12-12, minor elements, and 4 tons of dolomitic limestone broadcast.

Limestone increased soybean yields by 40 percent in the early planted soybeans and by 144 percent in the late planted soybeans on Weston fine sandy loam. Treatments without lime on Leon fine sand registered almost complete failures on both early and late plantings. With lime, however, this soil averaged 12.7 and 18.7 bushels per acre for early and late plantings, respectively.

Four tons of dolomitic limestone raised the pH of the Weston soil from 4.2 to 5.0 and that of the Leon from 3.8 to 5.3 four months after application. Additional fertilizer without limestone was no better than Treatment No. 1 on both the Weston and Leon soils.

Georgia

FERTILIZER NEEDED BY BERMUDAGRASS

William E. Adams, Watkinsville.--Coastal Bermuda has averaged about 60 percent more forage per acre than common Bermuda in a two year test involving different levels of soil fertility both with and without crimson clover. Yields of clipped forage at four soil fertility levels are given below, on a dry matter basis.

Fertilizer per acre $N-P_2O_5-K_2O$	Yield of dry matter per acre			
	Coastal Bermuda		Common Bermuda	
	After clover	No clover	After clover	No clover
Pounds	*Tons*	*Tons*	*Tons*	*Tons*
0-0-0	2.21	1.67	1.56	1.04
100-50-50	3.98	4.16	2.78	2.37
200-100-100	5.62	5.47	3.64	3.69
400-200-200	7.33	7.15	4.33	4.61

The nitrogen, phosphorus and potassium were derived from ammonium nitrate, superphosphate and muriate of potash, respectively.

Coastal bermuda was particularly outstanding under heavy fertilization, with yields in excess of 7 tons per acre per year. Moreover, two-thirds of this production was obtained during July and August.

Crimson clover produced 1 to 1-1/2 tons per acre and, in addition, increased the yield of both Coastal Bermuda and common Bermuda about 1/2 ton per acre when no nitrogen was applied.

Soil acidity was markedly increased by heavy applications of ammonium nitrate. The following tabulation shows pH values at the end of 2 years, just before the plots were relimed:

Nitrogen applied, per acre per year	pH
0	5.7
50	5.5
100	5.4
200	5.2
400	4.8

The soil acidity data emphasize that high nitrogen fertilization programs must be accompanied by an adequate liming program.

Mississippi

COASTAL BERMUDA, CRIMSON CLOVER RESPOND TO SULFUR AT MC NEIL

C. E. Bardsley, Jr., State College.--Data obtained from a three-year experiment on Norfolk fine sandy loam at McNeil show definite responses to sulfur on Coastal Bermudagrass. The grass was grown in a crimson clover-Coastal Bermuda sequence, and liberally fertilized with nitrogen to promote maximum growth.

Four cuttings of clover and seven cuttings of grass have been made in the three-year period. The sulfur treatments and yields of crimson clover and Coastal Bermudagrass are given in the accompanying table together with the increases in dry matter due to sulfur.

Yields were significantly increased in three clover cuttings and in four grass cuttings. Increasing rates of sulfur did not result in step increases in yield. The four-pound rate was adequate when applied annually.

In the first year of the experiment, grass yields were not affected by sulfur additions. In the second year, the first cutting of grass following sulfur-responsive clover, was increased in yield by sulfur. This may have been an indirect effect, due primarily to increased nitrogen fixation by the sulfur-treated clover. In the third year, three successive crops of grass following the clover responded to sulfur. Response of this duration cannot reasonably be attributed to the clover. Liberal nitrogen fertilization may have contributed in either or both of two ways; (1) by greatly increasing grass yields and consequent uptake of sulfur, and (2) by altering the N:S balance in nutrients offered to the grass.

Yields of crimson clover and Coastal Bermudagrass over a three-year period as affected by sulfur treatments, McNeil, Miss.

Sulfur applied[1]	Yields of dry matter per acre	
	Crimson clover	Coastal Bermudagrass
Pounds	*Pounds*	*Pounds*
0	6,869	22,570
4	8,213	24,873
8	8,408	23,729
16	8,086	25,690
32	8,503	24,700
Average for sulfur treatments	8,303	24,748
Increase for sulfur	1,434	2,178

Basal fertilization: 1800 pounds per acre of 0-26-26 in four applications
Nitrogen applied at 100 pounds per acre following each cutting of grass during period of active growth.

[1] Sulfur supplied as gypsum with 0-26-26 fertilizer.

CROP GROWTH ON SUBSOILS IMPROVED BY P AND Zn

Jack L. Nelson and C. L. Crawford, Prosser.--Crop yields on areas cut in land leveling operations in the Columbia Basin can generally be increased to near normal with the addition of commercial fertilizers. Little can be done, however, to restore soil conditions favorable to normal crop development where little or no soil remains above rock, gravel, or caliche.

The nitrogen requirement for cut areas is usually not materially increased over that for the uncut areas because in either case nearly all of the nitrogen required by the crop must be added as fertilizer.

Phosphorus has been found to be the most acutely deficient element. As can be seen in the accompanying table, large phosphorus responses were obtained in each of four fertility experiments on cut areas. Deficiency symptoms and leaf analyses also indicated severe phosphorus deficiency. The phosphorus status can be determined adequately with a soil test using $NaHCO_3$ as the extracting agent. There is some indication that rates of P_2O_5 as high as 200 pounds per acre may be necessary to overcome these severe deficiencies where soil tests show a value below five pounds per acre.

Zinc deficiencies on susceptible crops are also severe on most cut areas. Zinc deficiency is worse on cuts than on noncut areas because Columbia Basin soils generally increase in lime and pH with depth. Lime decreases the availability of zine in the soil.

Potassium deficiencies can also be expected on some heavy cuts. There appears to be some potash response on two of the experiments listed in the table. Leaf analyses and deficiency symptoms of plants on some cuts also indicate some potash deficiencies. Soil tests indicate that available potassium, like phosphorus, decreases with depth.

Effect of fertilizer on the yield of crops grown on exposed subsoils, Columbia Basin, Wash.

Fertilization pattern				Crop yield per acre			
				Beans	Beans	Barley	#1 Potatoes
N	P_2O_5	K_2O	Zn	Warden silt loam	Ephrata loamy sand	Wheeler fine sandy loam	Burke
				Pounds	*Pounds*	*Bushels*	*Tons*
0	0	0	0	995	283	17.4	--
+	0	0	0	1,818	--	--	5.6
+	+	+	+	--	1,601	30.3	14.3
0	+	+	+	--	1,352	--	--
+	0	+	+	--	521	16.7	--
+	+	0	+	2,494	1,023	20.3	14.8
+	+	+	0	2,409	1,362	23.4	15.1
L. S. D. (.05)				766	850	7.8	3.4
Uncut area				1,850	2,412	34.6	15.7

Applications of all other essential plant nutrients to the cut areas did not improve the yield of the crops grown.

Kansas

OM, TEXTURE, CLAY TYPE INFLUENCE SOIL CRUST STRENGTH

R. J. Hanks, Manhattan.--The results of recent tests show that organic matter, soil texture and type of clay influence soil crust strength. Crust strength was measured by determining the modulus of rupture of briquettes. The briquettes were formed by wetting for one hour with artificial rain having an intensity of 2 inches per hour.

Table 1 is a summary of this study. The data show the crust strength on all soils studied was increased from 2 to 20 times upon removal of the organic matter. Before organic matter removal, the relation of texture to crust strength was not indicated clearly. However, after organic matter removal, crust strength increased with increasing clay content. The results fail to show any outstanding differences between soils with different types of clay minerals.

Table 1.--Influence of organic matter and texture and clay mineral on crust strength, Manhattan, Kans.

Soil	Modulus of rupture		Sand	Clay	Predominant clay mineral
	Before OM removal	After OM removal			
	Bars	*Bars*	*Percent*	*Percent*	
Garden City sandy loam.....	0.30	4.29	75	15	Illite
Keith loam.....	.49	6.17	40	25	Montmorillonite
Albion sandy clay loam.....	2.40	6.31	50	30	Illite
Munjor silty clay loam.....	2.15	7.01	15	40	Montmorillonite and illite
Ladysmith clay.....	.56	10.67	5	60	Montmorillonite
Kaolinitic subsoil clay.....	4.72	12.02	10	60	Kaolinite
Wabash silty clay loam.....	--	4.37	15	40	Montmorillonite and Illite
Summitt clay.....	--	9.58	15	50	Illite

Another test was made to determine the influence of clay content and clay type on crust strength. Relatively pure clays were mixed with various quantities of sand and briquettes formed. Table 2 shows the results of this study. At constant clay content the kaolinitic clay appears to result in a higher crust strength than the illite. These data show the same trends as the data of Table 1, i.e., crust strength increases as clay content increases and that kaolinitic crusts are just as hard if not harder than those formed with illite type clays.

Table 2.--Influence of clay content and clay type on crust strength in clay-sand mixtures, Manhattan, Kans.

Clay content	Crust strength	
	Kaolin	Illite
Percent	*Bars*	*Bars*
20.....	3.5	0.6
40.....	5.5	2.5
60.....	11.4	3.6
80.....	9.0	6.2
100.....	14.9	9.6

North Dakota

LEGUME AFFECTS FERTILIZER RESPONSE

C. W. Carlson, D. L. Grunes, J. Alessi and G. A. Reichman, Mandan.--At the Deep River Development Farm in North Dakota, fertilizer response in a rotation of barley, corn, and potatoes is being compared to response in a rotation of barley, three growing years of alfalfa harvested several times each year, corn, and potatoes. In the nonlegume rotation, yields generally increased when nitrogen was applied but frequently decreased when phosphorus alone was applied. Phosphorus applied with nitrogen gave higher yields than nitrogen alone. The data are summarized in the accompanying table.

When alfalfa was included in the rotation, barley, corn, and potato yields increased when phosphorus was added. Nitrogen alone decreased barley yields but increased potato yields. Corn yields were not influenced by nitrogen fertilizer in the legume rotation. Nitrogen and phosphorus applied together increased yields over all of the other treatments.

Yields with the nitrogen treatment were generally about the same in both rotations. Yields of all crops in the legume rotation were higher than in the nonlegume rotation with comparable fertilizer treatment. One important effect of the alfalfa in the rotation is the fixation of nitrogen, and release of this nitrogen to succeeding crops. However, since yields were generally higher for the legume rotation than for high rates of nitrogen fertilization in the nonlegume rotation, it appears that other factors are also involved. Additional work is under way in an attempt to understand these factors.

Effect of fertilizer treatment and legume on yields of barley, corn and potatoes, Mandan, N.D.[1]

Fertilizer treatment[2]	Crop yield per acre					
	Barley		Corn forage[3]		Potatoes	
	Non-legume	Legume	Non-legume	Legume	Non-legume	Legume
	Bushels	*Bushels*	*Pounds*	*Pounds*	*Bushels*	*Bushels*
Check	49.5	58.2	7,410	9,080	393	426
N	45.2	45.8	8,550	8,950	444	469
P	48.4	70.4	6,200	9,510	348	478
N+P	64.5	86.7	9,550	10,490	489	524

[1]Barley yields are for 1956; corn yields are averages for 1954, 1955, and 1956; and potato yields are averages for 1955 and 1956.
[2]N rates were 40, 80, and 120 pounds per acre for barley, corn, and potatoes respectively.
[3]Oven dry weights.

Maryland

NITRATE N PRODUCTION INCREASED BY WINTER COVER CROPS

Victor J. Kilmer, Clarence S. Slater, and Clarence S. Britt, Beltsville.--Winter cover crops, adequately fertilized, aid in maintaining an adequate supply of available nitrogen to the growing crop that follows. Tobacco, planted after different winter cover crops and winter fallow, has been grown annually in a one-year rotation on Evesboro-Sassafras sandy loam for the past ten years. On one series of plots the cover crop is turned under early, about April 10; on another series the cover crop is turned under late,

about May 10. A total of 1500 pounds per acre of 4-8-12 has been applied annually to each plot, being divided into one fall and two spring applications. (See Quarterly Report No. 8.)

Soil samples taken in June 1955 were placed in a constant temperature--constant humidity room. The production of nitrate nitrogen was measured at 3-week intervals for a period of 15 weeks and final measurement made at the end of 25 weeks. Cumulative results are given in the accompanying table.

The production of nitrate nitrogen in these soils was highest where winter cover crops were grown. Under laboratory conditions increases of up to 50 pounds per acre of nitrate nitrogen were obtained for the early turned covers. Late turned covers showed increases amounting to as much as 74 pounds of nitrate nitrogen per acre when compared with plots that were winter fallowed.

Cumulative nitrate nitrogen produced following different winter cover crops as affected by time of turning under the cover crop, Beltsville, Md., 1955.

Winter cover	Nitrate N produced per acre after indicated number of weeks-*						
	3	6	9	12	15	25	Increase over fallow
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
				Cover crop turned under April 10			
Fallow	22	32	38	44	52	66	--
Vetch	20	32	40	48	60	84	18
Wheat-Vetch	28	38	50	60	72	100	34
Ryegrass + N**	26	42	52	64	74	102	36
Ryegrass	28	40	52	64	76	104	38
Ryegrass-Vetch	30	42	52	68	82	110	44
Rye-Vetch	36	50	60	74	86	116	50
				Cover crop turned under May 10			
Fallow	18	26	32	36	44	62	--
Vetch	36	48	56	64	76	112	50
Wheat-Vetch	28	42	54	64	80	112	50
Ryegrass + N**	40	56	70	84	100	132	70
Ryegrass	36	52	60	72	86	116	54
Ryegrass-Vetch	32	46	58	72	88	124	62
Rye-Vetch	48	62	72	84	100	136	74

* Average of duplicate samples from two replicates.
** Forty pounds of additional nitrogen applied.

Puerto Rico

COFFEE GROWN SUCCESSFULLY IN FULL SUNLIGHT

Jose Vicente and Fernando Abruña, Rio Piedras.--A combination of high plant populations and intensive management practices in Puerto Rico has produced more than a ton of sun-grown market coffee per acre only 2-1/2 years after the trees were transplanted to the field. Essential practices are: use of an adapted variety, close planting in hedges, heavy fertilization, spraying for control of insects and diseases, and proper pruning of the coffee trees. The current farm price of coffee in Puerto Rico is about 60 cents per pound.

The data below show the strong response of coffee to nitrogen fertilization in this experiment when all other nutrients were provided in abundance.

Nitrogen per acre yearly	Market coffee per acre
Pounds	*Pounds*
0	920
100	2,040
200	2,400

Heretofore, all coffee in Puerto Rico has been grown under shade. Average yields of coffee in Puerto Rico are about 150 pounds of coffee per acre compared with yields of about 400 pounds throughout Latin America where much of the coffee is grown in full sunlight. Previous attempts to grow coffee in full sunlight in Puerto Rico have met with failure.

RESIDUE MANAGEMENT

Idaho

MORE SNOW RETAINED, FROST DEPTH REDUCED BY STUBBLE

F. H. Siddoway, St. Anthony.--Leaving small grain stubble undisturbed through the winter following harvest creates a number of favorable conditions as a chain reaction: the early snowfall is retained in place against windsweep before the soil is frozen; the insulating effect of the winter snow cover minimizes or prevents soil frost; with unfrozen soil, moisture intake potential is improved when the snow melts in the spring; and the resultant increase in available soil moisture substantially increases yields of the following wheat crop.

A previous report, Quarterly Report No. 2, pp. 45, 46 showed that a higher yield of winter wheat was produced in 1954 on plots on the Tetonia Experiment Station where the stubble was left standing after the 1952 wheat harvest than on plots with the stubble removed by mowing or by burning. A winter wheat crop was harvested from these same plots in 1956 with yields as recorded in the accompanying table. Soil moisture determinations made at periods prior to the 1956 growing season indicated that differences in available soil moisture could account for the crop yield differences obtained.

Snow pack depth and soil frost measurements on these plots describe the results of a phase of the weather phenomena from October 23 to November 9, and offer an explanation of soil moisture and yield differences obtained from these treatments. For the period between the above dates, 1.5 inches of precipitation was received in the form of snow which was accompanied by wind and subsequent drifting. Temperatures during most of this period were well below freezing and any exposed soil was frozen.

Where the stubble was left standing, snow cover was continuous, while the plots on which the stubble was cut and removed or burned were intermittently covered and exposed.

Snow depth, snow moisture content and soil frost depth and wheat yield resulting from three stubble management treatments, Tetonia Experiment Station, Idaho, 1956[1]

Treatment	Snow depth	Snow moisture content	Soil frost depth	Wheat yield per acre
	Inches	*Inches*	*Inches*	*Bushels*
Stubble left standing, fall 1956[2]	7.8	1.5	0	28.2
Stubble cut and removed, fall 1956[3]	3.2	.6	1	24.0
Stubble burned, fall 1956	2.1	.4	3	23.6
L.S.D. 5%	.8	.2		
L.S.D. 1%	1.1	.3		

[1]Yield in 1956; other measurements November 9, 1956.
[2]Stubble height 13 inches.
[3]Two inches of standing stubble remained on this treatment.

If the early snow cover remains in place before the soil is frozen, the moisture intake potential when the spring thaws occur is increased since the insulating effect of the snow cover helps prevent excessive soil frost during the winter. Beneficial effects of the standing stubble, other than retaining the snow in place by preventing its removal by wind, may be evident in keeping the soil in a condition more favorable for moisture intake.

Texas

ORGANIC MATTER CONTENT HIGHEST WITH SUBBBLE-MULCH TILLAGE

C. E. Van Doren and J. J. Bond, Bushland.--Stubble-mulch tillage under dryland conditions has maintained the soil organic matter content at a higher level than oneway tillage, irrespective of the cropping system used.

Chemical analyses of soil samples from plots established in 1941 on Pullman silty clay loam showed that stubble-mulch plots averaged 7.4 percent more organic matter than the one-wayed plots; see accompanying table. Continuously cropped plots were higher in organic matter than wheat-fallow plots where stubble-mulch tillage was used. The cropping system apparently had little effect on the organic matter content under one-way tillage.

Organic matter has declined since 1941 under all treatments as shown in the accompanying figure. However, the decline has been the least under the stubble-mulch tillage-continuous wheat culture.

Organic matter content of the stubble-mulch experiment plots, 0 - 6 inch depth, Southwestern Great Plains Field Station, Bushland, Texas, 1956

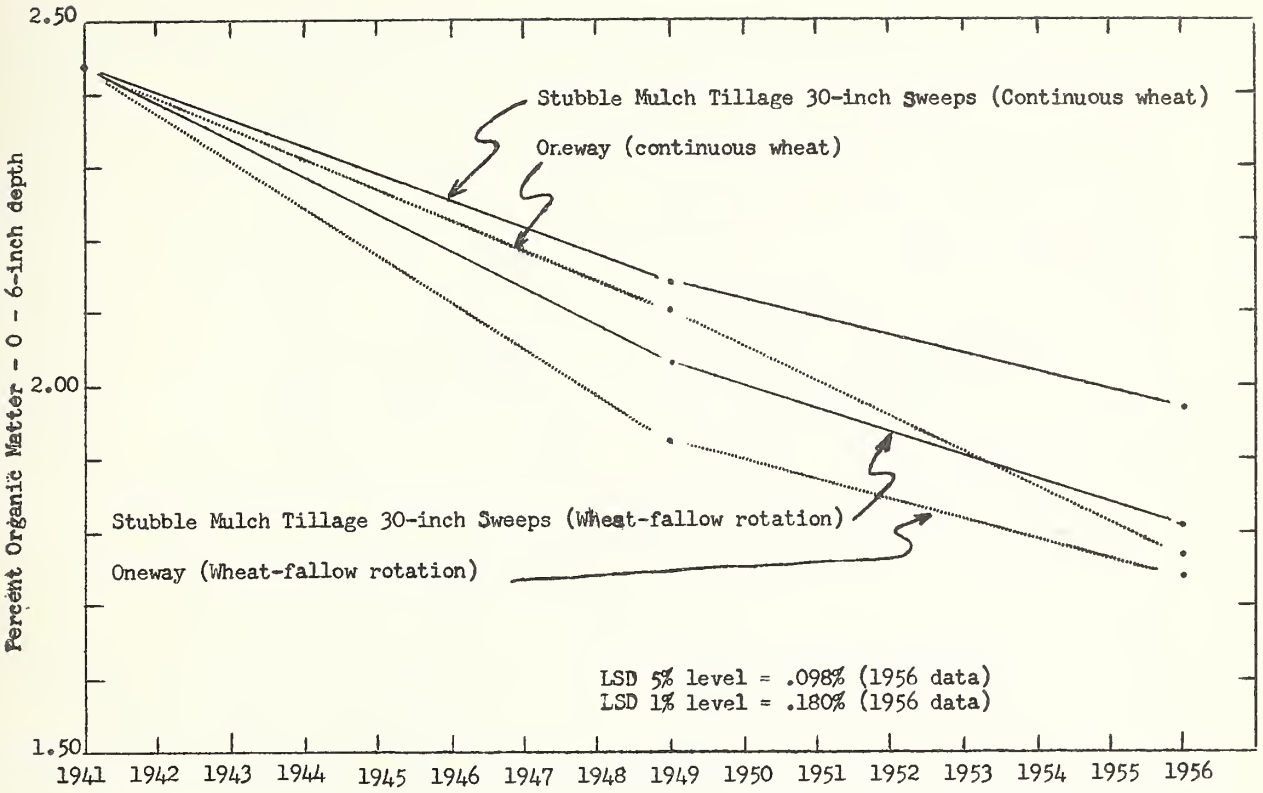
Tillage	Cropping system		Tillage means
	Continuous wheat	Wheat-fallow	
	Percent	*Percent*	*Percent*
Stubble-mulch 30-inch sweeps	1.97	1.81	1.89
Oneway disk	1.78	1.74	1.76
Cropping system means	1.88	1.78	----

	L.S.D. 5%	L.S.D. 1%
Cropping system means	.069	.127
Tillage means	.069	.127
Individual values	.098	.180

Georgia

SAWDUST INCREASED EMERGENCE OF SNAP BEANS

H. G. Ukkelberg and R. L. Green, Fleming.--The application of sawdust in the spring of 1954 to Bladen fine sandy loam reduced the time required for emergence of snap bean seedlings during a dry period in 1956. Stand counts made 12 days after planting showed a 43 percent stand with no sawdust, 60 percent with 30 tons of sawdust, and 61 percent with 60 tons. After the above stand counts were made, moisture conditions improved and final stands were uniformly good for all treatments.



Changes in organic matter content in the 0 - 6 inch depth of Pullman silty clay loam soil as a result of various tillage and cropping practices, Bushland, Texas, 1941-56.

TILLAGE AND CULTURAL PRACTICES

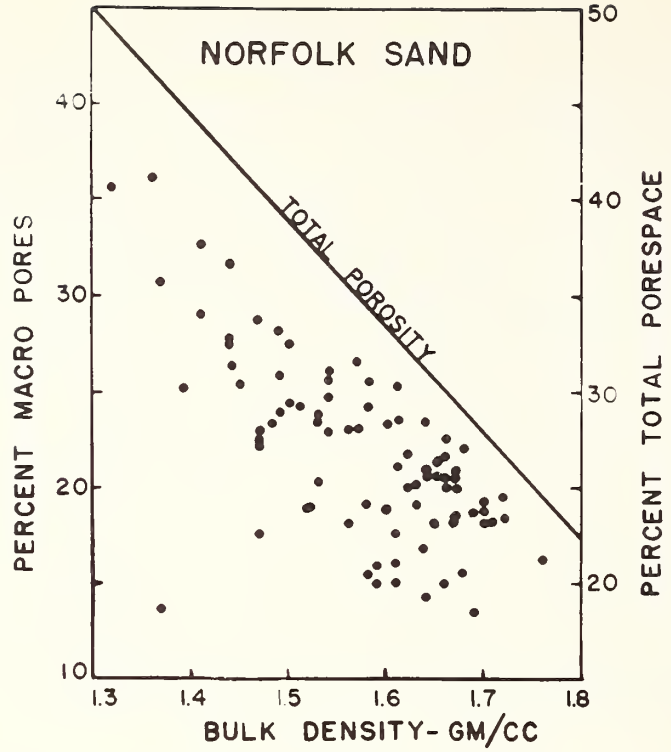
Alabama

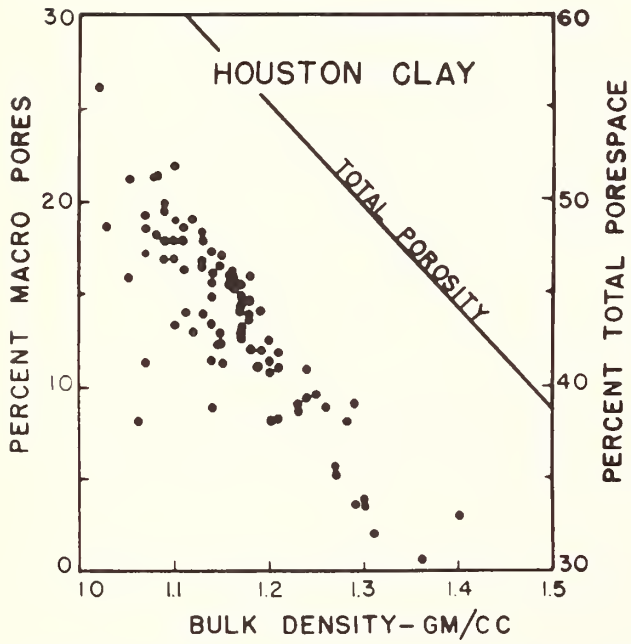
SOIL COMPACTION DESTROYS MACROPORES

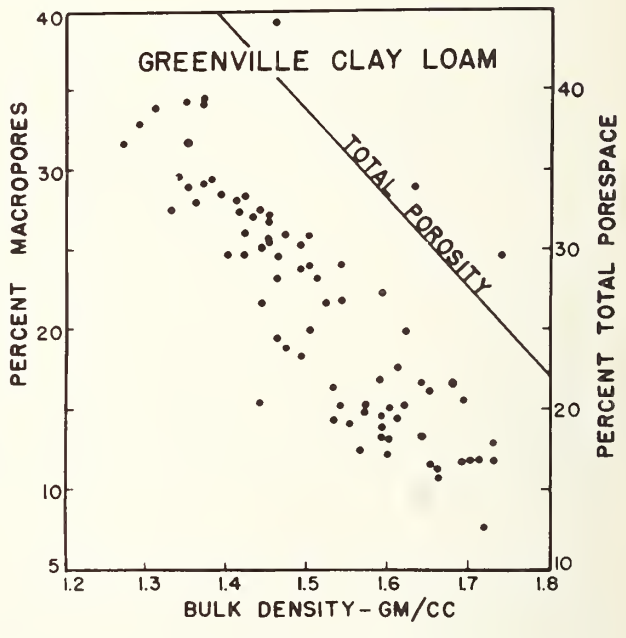
William R. Gill, I. F. Reed, and W. F. McCreery, Auburn.--Alabama studies indicate that the decrease in soil volume from compaction is almost entirely at the expense of the macropores. These pores are the large soil pores which are easily drained and are generally considered as being important in soil aeration. Total porosity was calculated. Macro-porosity was measured.

The accompanying figure shows the relationship between percentage of macropores, total porosity, and soil density for a Houston clay soil, Greenville clay loam, and a Norfolk sand. It should be noted that the effect of soil density on the macropores nearly parallels that on the total porosity in each soil.

Under normal conditions, soil tillage increases macroporosity, decreases density, and loosens the soil. All of these factors are considered as being correctives for soil compaction and beneficial for plant growth, hence, compaction damage should not be considered as irreparable.





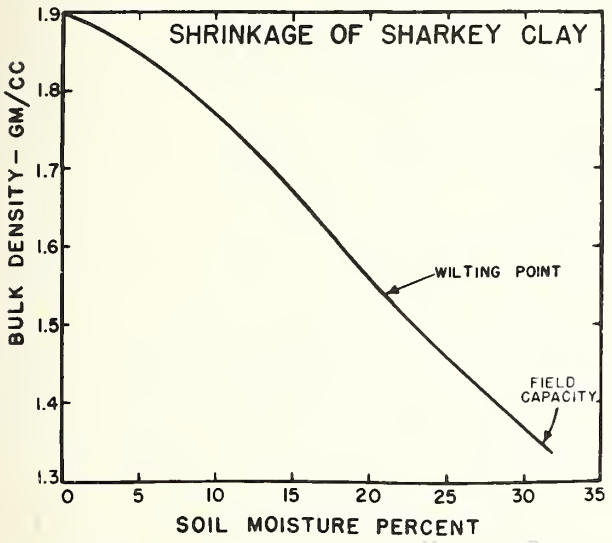


The percentages of macropores and total pores in Houston clay soil, Greenville clay loam, and Norfolk sand. Each dot on the chart represents a measurement of macro-porosity on clods with different bulk density.

Alabama

SOIL SHRINKAGE MAY AFFECT INTERPRETATION OF TILLAGE TESTS

William R. Gill and Carl A. Reaves, Auburn.--In studies at the Tillage Machinery Laboratory, the loss of moisture from certain soils was accompanied by soil shrinkage as indicated by loss of soil volume and increase in bulk density. The accompanying figure shows the shrinkage pattern for natural clods of a clay soil. The change of soil density for each percent change of soil moisture was seen to be about .02 gm/cc. Thus, as the soil dried out during the summer months, there was an increase in soil density due to the loss of soil moisture. The nature of tillage operations involved may alter the density in addition to this amount. Any treatment which would affect the moisture status, such as a mulching treatment, would also affect soil density. In cases where tillage and mulching treatments are superimposed on each other, interpretation of the results might lead to an exaggeration of the actual results. Moisture differences resulting from different sampling dates or different locations would have the same effect on density. Soil density changes resulting from one percent difference in soil moisture vary from 0.003 to 0.029 gm/cc. for soils ranging from sandy loams to clays. In the latter case, a three percent moisture difference at the time of sampling would account for 0.1 gm/cc. difference in density. Comparisons may be made without considering moisture differences only when treatment differences are greatly in excess of those expected from shrinkage.



Shrinkage relations for natural clods of a Sharkey clay, Auburn, Ala.

Indiana

VERTICAL MULCHING IMPROVES STRUCTURE, CONSERVES WATER

D. L. McCune, J. F. Parr, J. M. Spain and L. D. Meyer, Lafayette.--Evidence obtained at Lafayette, Indiana indicates that vertical mulching may alter soil structure and thus have a beneficial effect on infiltration and plant growth over an indefinite period. An earlier report on this study appeared in Quarterly Report No. 7. After one year, vertically mulched channels in a pasture field were still quite prominent. Soil structure, as measured by bulk density, adjacent to the vertically mulched channel, was altered significantly as shown in Table 1.

Table 1.--Effect of Vertical mulching on bulk density of the B horizon of a Crosby silt loam soil eleven and sixteen months after applications, Lafayette, Ind.

Date of sampling	Bulk density	
	Distance from channel	
	0-3 Inches	7-10 Inches
June 1956	1.28	1.43
Nov. 1956	1.35	1.53

A significant difference in aggregate stability due to vertical mulching was also noted from samples collected in November 1956. Aggregate stability was measured by the number of grams of soil remaining on a 0.21 mm. sieve from a 25-gram sample after 10 minutes of wet sieving. These data are shown in Table 2.

Table 2.--Effect of vertical mulching on aggregate stability, sixteen months after application, Lafayette, Ind.

Distance from channel	Aggregate stability	
	Vertical mulched	Subsoiled
0-3 Inches.....	14.8	8.8
7-10 Inches.....	12.0	9.9

Vertical mulching channel in July 1956, eleven months after treatment. Note the stability of the channel and the soil moisture pattern. Lafayette, Ind.

This change in aggregate stability appeared to be correlated with earthworm activity. An abundance of earthworm casts was noted adjacent to the vertical mulched channel and with only a few adjacent to subsoiled channels.

The accompanying figure shows how prominent the vertical mulched channels remained eleven months after establishment. It also indicates the water conserving characteristics of such channels.

Wisconsin

MULCH HANDLING OF WINTER COVER REDUCES EROSION UNDER TOBACCO

Clyde E. Bay, Madison.--A mulch obtained by subtillage of a winter crop reduced erosion under continuous tobacco at Madison, Wisconsin, during the last 3 years from 33.6 tons per acre annually to 12.2 tons. This method of handling the cover crop was materially more effective in control of runoff and erosion than plowing it under before planting the tobacco. The beneficial effect of the cover crop was noted during the entire season.

The plots were cropped to tobacco annually and received 20 tons of barnyard manure and up to 1,500 pounds of 3-9-18 per acre per year. After the tobacco was harvested in early September, the stubble was disked and a rye-vetch mixture was planted on two of the treatments. About May 15, the barnyard manure and fertilizer were applied and the no-cover crop and one of the cover crop treatments were plowed. The other cover crop treatment was subsurface tilled to develop a mulch in the surface area.

Total and average monthly soil and water losses are shown in the accompanying table.

Monthly precipitation and losses of soil and water from tobacco, June 1953 to May 1956, Madison, Wis.

Month	Precipitation causing losses	Plowed No Cover crop		Plowed Rye-vetch cover crop		Subsurface tilled Rye-vetch cover crop	
		Runoff	Soil loss[1]	Runoff	Soil loss[1]	Runoff	Soil loss[1]
	Inches	*Inches*	*Tons*	*Inches*	*Tons*	*Inches*	*Tons*
April.....	9.94	3.82	31.13	1.56	5.66	1.52	5.17
May.....	6.13	1.03	4.94	0.30	0.58	0.40	0.59
June.....	9.89	3.69	13.51	2.00	5.09	1.54	2.74
July.....	8.28	3.40	39.11	2.45	31.84	2.23	20.81
August....	1.85	0.39	1.43	0.20	0.73	0.18	0.23
September.	1.28	0.13	0.46	0.16	0.76	0.12	0.48
October...	2.95	1.14	10.33	1.10	7.82	1.01	6.49
Total.....	40.32	13.60	100.71	7.77	52.48	7.00	36.51
Annual Average.	13.44	4.53	33.64	2.59	17.49	2.33	12.17

[1]Soil loss per acre.

Arizona

MINIMUM SEEDBED PREPARATION INCREASES COTTON YIELD

Leonard J. Erie, Phoenix.--Minimum seedbed preparation involving plowing, irrigating, and harrowing for cotton outyielded other more elaborate preparation operations from 145 to 260 pounds of lint cotton per acre. Moreover, from $3 to $15 per acre were saved in labor, equipment operation, and irrigation water costs by the minimum treatment.

The results reported are from the third year of acala 44 cotton in a rotation of alfalfa-barley, 2 years -cotton, 4 years -alfalfa on the Mesa Experimental Farm of the University of Arizona.

The seedbeed preparation treatments used and the resultant yield of cotton are shown in the following table:

Seedbed preparation operations	Yield of lint cotton per acre
	Pounds
Plow, irrigate, harrow...	1,740
Plow, disk, drag, irrigate, disk.....	1,480
Plow, disk, irrigate.....	1,540
Plow, irrigate, disk.....	1,595
Plow, irrigate, disk, irrigate, disk.....	1,558

Results indicate that:

1. The greater yield of lint cotton from plots receiving minimum seed-bed treatment over each of the other treatments is significant at the 5% level.

2. Yield differences among the remaining treatments are not significant.

3. As indicated, the greater yield resulting from a minimum seedbed preparation was produced at a considerable saving in labor, equipment operation, and irrigation water cost.

Nebraska

ADEQUATE STORED SOIL MOISTURE ASSURES HIGH CORN YIELD

F. L. Duley, Lincoln. --The value of stored soil moisture at corn planting time was well illustrated in work by Dr. Ralph E. Leubs at Lincoln, Nebraska, in 1956. On plots where a late crop had grown the previous year there was practically no available soil moisture below the second foot. On certain of these plots one irrigation sufficient to wet the soil to a depth of about five to six feet was applied before planting corn. The yield of corn on the non-irrigated plots was only two bushels per acre, in spite of the fact that the rainfall after July was about normal. The low yield was due to the fact that there was no reserve moisture to support the plants during the hot, dry periods in July and August. On the land which received the preplanting irrigation there was sufficient moisture in the subsoil to support the plants during these hot, dry periods so that the plants were not injured, and the final yield was 76 bushels per acre.

Somewhat similar results were obtained on other areas of the experimental field where no irrigation was practiced but where, in some cases, more moisture had been stored in the subsoil. These results were reported in Quarterly Report No. 11 and show that the yields varied from 2.4 bushels to 68.9 bushels per acre depending on how much moisture was stored in the soil profile. Under Great Plains conditions every effort should be made to allow sufficient time between crops to store moisture for the next crop. Where water is available a preplanting irrigation should be applied if there is a distinct shortage of moisture in the profile.

Kansas

THIN STANDS OF GRAIN SORGHUM YIELD BEST DURING DROUGHT

Paul L. Brown, Hays. --A low plant population of 30,000 plants per acre of grain sorghum planted on fallow land with deep moisture reserves produced highest grain yields in 1956, the driest year on record, at Hays, Kansas. The soil, Munjor silt loam, was wet to an average depth of seven feet and contained more than 10 inches of available water at planting time. Such deep fallow moisture reserves are unusual. Only 1.25 inches of rain fell from emergence to maturity.

Midland Milo sorghum was planted in 10-, 20-, and 40-inch rows with plant populations of 30,000; 60,000; 90,000; and 120,000 plants per acre. Each treatment was replicated four times. The crop was planted on July 5, which was ten days later than the latest planting date recommended to farmers. The normal recommended planting interval is May 25 to June 20. The delayed planting date was due to dry surface conditions in June that made it impossible to drill the seed into moist soil. Rain in early July made it impossible to plant on July 5. Except for reduced height, plant development was almost normal in spite of the small amount of rainfall during the growth period. Heading was complete by September 10, three weeks later than normal. Temperatures remained above average in September and early October. This permitted the crop to mature prior to the first frost on October 21. Data are presented in the accompanying table.

Yield differences due to row spacing were not significant. The greatest yield was produced by the lowest plant population. As the population increased, the yield decreased. The importance of thin grain sorghum stands in severe drought years is emphasized.

There were three striking results obtained in this experiment:

1. Grain sorghums will mature in the Hays area when planted as late as July 5 in certain years such as 1956.

Average grain sorghum yields for four plant populations and three row spacings, Hays, Kans., 1956

Row spacing	Yield per acre				
	Plants per acre				Row space means
	30,000	60,000	90,000	120,000	
Inches	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
10.....	27.8	28.3	16.0	11.6	20.9
20.....	29.7	16.4	9.8	11.1	16.8
40.....	25.5	22.4	20.6	23.2	22.9
Population Means..	27.7	22.4	15.5	15.3	20.2

L.S.D. 5% for population means 5.2
L.S.D. 5% for row space means N.S.

2. More than 80 percent of the total water use was from stored moisture in the soil at emergence time. Since the average yield for the experiment was 20.2 bushels per acre and the highest average treatment yield was 29.7 bushels per acre, this indicates that fair grain yields can probably be produced solely on stored moisture.

3. Low plant populations are essential for maximum grain production in severe drought years. A population of 30,000 plants per acre is equivalent to 1-1/2 to 2 pounds of germinated seed per acre.

Texas

NARROW ROWS BEST FOR FERTILIZED HYBRID SORGHUM

K. B. Porter, M. E. Jensen, and W. H. Sletten, Bushland.--Grain yield from 12-inch row spacing averaged 1,000 pounds more than from 40-inch row spacing. The grain yield from 12-inch row spacing with 6 pounds per acre planting rate produced 8,130 pounds of grain per acre, 1,400 pounds more than the 40-inch row spacing.

This experiment was seeded on July 3 and harvested on November 6 and 7. Hybrid grain sorghum RS610 was used. The experiment consisted of four row spacings, 12, 20, 30, and 40 inches; three planting rates, 6, 12, and 18 pounds per acre; and two nitrogen rates, 100 and 200 pounds per acre. The experiment was located on land being irrigated for the first time, although it had been cropped previously under dryland conditions (Pullman silty clay loam). There was no response to nitrogen.

As the planting rate was reduced the weight of individual heads increased from 0.065 at the 18-pound planting rate to 0.136 pound per head at the 6-pound planting rate.

Plants on the 6-pound planting rate bloomed 1.0 and 1.5 days earlier than the 12- and 18-pound seeding rates, respectively. Row spacing had no significant influence on date of first bloom. Tillering was greatest in the 6-pound seeding rate. Row spacing had no significant influence on tillering.

Row spacing affected the plant height significantly. Height in the 12-inch spacing averaged 3.74 feet as compared to 4.1 feet for the 40-inch row spacing. Part of this difference may be due to the small differences that occurred in soil moisture content before irrigating, since all plots were irrigated on the same day. The narrow row spacing used more water early in the season resulting in a small moisture differential between the row spacing during the jointing stage which may account for part of the difference in plant height. Future irrigations will be based on exact soil moisture levels and each row

spacing will then be irrigated according to its own soil moisture condition. There was no difference in total water use between the various row spacings.

When adequate soil moisture is maintained, as much as 84 percent of the soil moisture extracted by the sorghum comes from the top 2 feet of the soil. The average production of grain sorghum per acre-inch of water in this experiment was 314 pounds per acre.

Texas

EVAPORATION HIGH FROM DRY WEATHER CRACKS IN BLACKLAND SOIL

J. E. Adams and D. O. Thompson, Temple.--Cracks develop in soils of the Texas Blackland area during periods of low rainfall and high temperatures. These cracks continue to form and widen as long as the drying conditions and shrinkage continue. They are generally recognized as having considerable effect on water intake from any rains that occur when these conditions are present. Other work (Proc. Soil Sci. Soc. Amer. 9: 24-29, 1945) showed a lowering of soil moisture content within 3 inches on each side of dry weather cracks to a depth of 12 inches and a lowering of soil moisture near the crack to a depth of 24 inches.

In order to evaluate evaporation rates in soil cracks, samples of Blackland soil were placed in 1-inch wide moisture equivalent boxes, saturated, allowed to drain overnight, and then suspended for 163 hours at five depths in dry weather cracks in Blackland soil with Bermudagrass sod and Madrid sweetclover cover (Figure 1). Evaporation losses

Figure 1.--Typical dry weather cracks in Houston Black clay with Madrid sweetclover cover showing installation of apparatus used to suspend soil samples at 6 inch depth increments in the crack. Metal clamp holding moisture equivalent box at soil surface visible just below cross arm, Temple, Tex.

during this period showed the same general pattern for cracks in both Madrid sweetclover and Bermudagrass sod. The average soil moisture content of samples suspended in cracks in Madrid sweetclover is shown in Figure 2. The evaporation rate was greatest

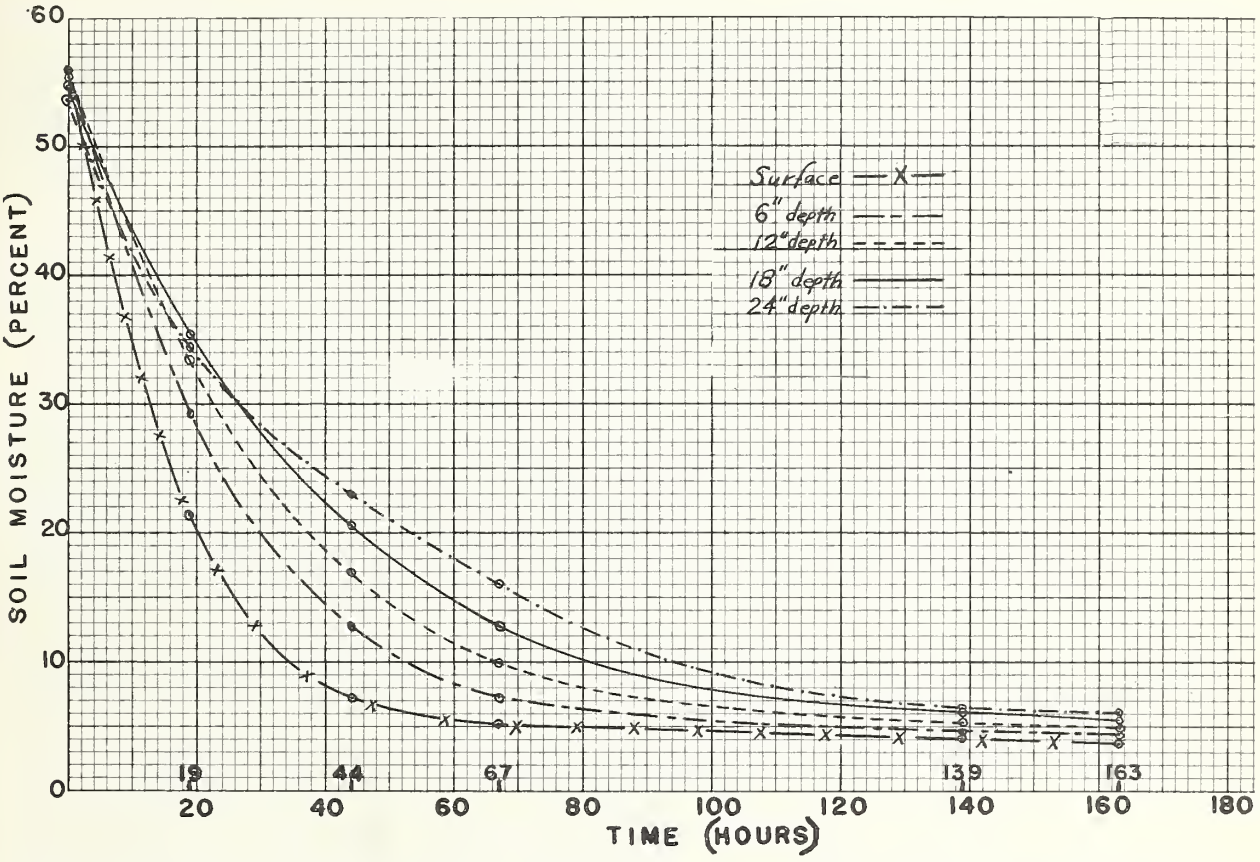


Figure 2.--Soil moisture content of soil samples suspended for 163 hours at five levels in dry weather cracks in Houston Black clay in Madrid sweetclover. Data collected September 5-11, 1956, Temple, Texas.

for all depths initially and decreased with time. The evaporation rate also decreased with depth with the greatest difference between depths occurring during the first 67 hours. At the end of 19 hours the evaporation rate at the 24-inch depth in the cracks varied from 52 to 58 percent of that at the surface level for both sweetclover and Bermudagrass sod. The ratio of the evaporation rate at the 24-inch to the surface depth increased with time due to the reduced moisture content of the surface samples. At the end of 44 hours the soil moisture percentage was reduced to or below the 15 atmosphere moisture retention value, about 18 percent, for all samples suspended at 12 inches or less in the cracks. By the end of 67 hours, samples suspended at all depths had been reduced below the 15 atmosphere moisture retention value. The evaporation rate at the end of 163 hours was practically the same for all depths under both Madrid sweetclover and Bermudagrass sod. When samples were changed every 24 hours there were indications that evaporation was less at the 24-inch depth under sweetclover than under Bermudagrass sod. This was probably due to shading or a windbreak effect, although the sweetclover was dead and growth had been very thin and sparse as seen in Figure 1.

HIGH TEMPERATURE, LOW MOISTURE LIMIT SPRING WHEAT YIELDS

T. J. Army, Bushland, Texas (formerly of Bozeman, Montana). --Rainfall is not the only climatic factor of major importance in dryland spring wheat production in Montana. Temperature also plays a significant role in the determination of grain yields. Longtime crop and weather data from three locations in Montana show that soil moisture at seeding and precipitation from seeding to heading generally are important in determining spring wheat yields under an alternate crop-fallow system. From heading to harvest, however, grain yields are most often limited by high maximum temperatures.

Precipitation prior to heading is beneficial to wheat production as shown by the standard partial regression coefficients of the accompanying table. However, if rain occurs after heading it may have a depressing effect on the grain yield. This is especially evident at Havre. Maximum temperatures following heading are apparently too high for the normal physiological development of the wheat plant. Grain yields, therefore, are negatively associated with maximum temperatures from heading to harvest.

The "R" values of the accompanying table indicate that by including measurements of soil moisture at seeding, and rainfall and maximum temperatures during the growing season in a multiple regression equation, approximately 70 percent of the variability in grain yields can be explained. A considerable portion of the variability in yields is related to factors yet to be determined. However, it appears that maximum temperatures definitely need to be considered in conjunction with moisture in evaluating growing conditions for spring wheat.

Standard partial regression coefficients for the multiple regression of yield as related to soil moisture at seeding and rainfall and maximum temperatures during growing season, Bozeman, Mont.

Location	Soil moisture at seeding		Seeding to tillering	Tillering to heading	Heading to soft dough	Soft dough to harvest	R
Havre.....	+.204	Precipitation	+.325	+.088	-.059	-.547	.829
		Maximum temp.	+.213	-.280	-.218	-.812	
Huntley....	+.313	Precipitation	-.040	+.269	-.088	-.061	.863
		Maximum temp.	+.101	+.129	-.682	-.055	
Moccasin...	-----	Precipitation	+.287	+.223	+.063	+.043	.823
		Maximum temp.	+.142	-.300	-.330	+.059	

Minnesota

SOIL AND WATER CONSERVATION PROGRAM INITIATED

C. A. Van Doren and Lee Hermsmeier, Morris. --A soil and water conservation research program was initiated in Minnesota in 1956 in cooperation with the Minnesota Agricultural Experiment Station. The major objective of the program will be the development of more effective methods of utilizing the soil and water resources in western Minnesota. Initial efforts will be devoted to methods of increasing intake and retention of rainfall and reducing erosion on the Fargo-Beardon, Clarion-Nicolelte-Webster, and the Barnes-Aasted soil associations.

HYDROLOGY-GENERAL

Texas

COMPUTED AND RECORDED RUNOFF ARE IN CLOSE AGREEMENT

R. W. Baird, Riesel. --Soil moisture and runoff were computed from daily rainfall on a 16-acre Houston Black clay terraced watershed (Y-6). The watershed is in a three-year rotation of cotton, grain sorghum, oats, and clover and is in oats and clover in 1957. The available soil moisture, and, subsequently, amounts of runoff were computed from daily rainfall by the water accounting method discussed in Quarterly Report No. 11. The computations were for a period starting January 25, 1957 when the soil moisture, as calculated from soil samples, was 4.9 inches. The computed soil moisture on April 5, 1957 was 6.6 inches. The soil moisture for that day calculated by weighing and drying soil samples was 6.9 inches.

The computed and recorded runoff for the first three months in 1957 are as follows:

Date	Runoff	
	Computed	Recorded
	Inches	*Inches*
February 1.....	0	.0015
February 23.....	0	.0056
March 20.....	.05	.0491
March 27.....	.02	.0019
March 31.....	.14	.1471
Total.....	.21	.2052

Texas

TIME OF CONCENTRATION ESTIMATED BY NEW FORMULAE

R. W. Baird and Monroe A. Hartman, Waco. --This item appeared on page 62 of Quarterly Report No. 7, February 1956 and page 47 of Quarterly Report No. 9, August 1956. Equation (1) should be corrected to read:

$$T_c = 5 + 75 \sqrt{A} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Arizona

TOMBSTONE WEATHER RECORD SUGGESTS DROUGHT SEVERITY

Joel E. Fletcher, Tuscon. --How severe is the present drought? Is it unusual or is it just the normal dry weather? Statistics just compiled shed some light on these questions

The rainfall record from Tombstone, Arizona, was used as a basis for calculations. By assuming that any rain smaller than the amount of evaporation for the same day is not significant, it was determined that, on an average, every year has one period of 80 days with no significant rain. Using the same assumption, the following results were obtained:

Number of days between rainfall	Average number of years between droughts of the intensity shown at left
80	1
99	2
124	5
143	10
174	20
182	40
193	60
207	100

These data may be interpreted in the following manner: On an average of once in 100 years there is one period of 207 consecutive days with no significant rainfall; on an average of once in 10 years there is one period of 143 consecutive days without a significant rain, and so on.

During the period of sixty-three years of record, all of the longer drought periods occurred during the months between January and July. The longest measured period without a significant rain was 181 days January 1 to July 3, 1893. The longest winter drought occurred during the winter of 1955-1956. The 1950's were also unique in that four of the ten longest droughts on record occurred during this period.

South Dakota

HYDROLOGIC STUDIES ESTABLISHED IN NORTHERN GREAT PLAINS

Armine Kuhlman, Newell.--Fifteen watersheds have been selected in Butte and Meade Counties in South Dakota for instrumentation and observation to determine the relationship of precipitation, soils, range conditions, and other watershed characteristics to seasonal and annual yields, discharges from individual storms, and sediment production. From this information, methods will be developed for estimating flows and sediment production from ungaged agricultural watersheds in a broad area in northwestern South Dakota, northeastern Wyoming, southeastern Montana, and southwestern North Dakota. The 15 watersheds range in size from 50 to 2000 acres and it is planned also to instrument some larger watersheds.

Runoff will be measured by instrumentation of existing reservoirs and sediment production by periodic surveys of the reservoirs. Soils will be mapped in detail and recurrent range condition surveys will be made. Each of the reservoirs has a large storage capacity in relation to its drainage area and little flow through the emergency spillway is expected. The headquarters for the project are at the Newell Irrigation and Dryland Field Station and the work will be carried out in cooperation with the South Dakota State Experiment Station.

Ohio

GREATEST FLOOD PEAKS FROM SMALL WATERSHEDS OCCUR IN SUMMER

L. L. Harrold, Coshocton.--The greatest flood peaks for the period 1937-56 for seven watersheds varying in size from 7.59 to 4,581 acres occurred mostly in the summer months. Data in the accompanying table show that maximum flood peaks (Order No. 1) on four out of the seven watersheds occurred in June. In fact, June, July, and September were the months in which the Number 1 and Number 2 flood peaks occurred on all seven

watersheds. The high-intensity, short-duration summer storms resulted in greater flood peaks than the long-duration, low-intensity winter-spring storms.

Seasonal occurrence of flood peaks for watersheds of 7.59 to 4,581 acres in size, Coshocton, Ohio, 1937-56

Month	Order number of annual floods*						
	Watershed size - Acres						
	4,581	2,570	1,570	920	303	75.6	7.59
Jan.....	-	5	-	-	-	-	-
Feb.....	4	4	3	5	6	6	6
Mar.....	-	-	5	-	-	-	-
Apr.....	-	6	4	6	-	-	-
May.....	-	-	-	-	-	5	-
June.....	1-2-6	2	2	1-2	1	2-3	1-2
July.....	5	3	1-6	3	5	-	4
Aug.....	-	-	-	-	4	-	-
Sept.....	3	1	-	-	2-3	1-4	3-5
Oct.....	-	-	-	4	-	-	-
Nov.....	-	-	-	-	-	-	-
Dec.....	-	-	-	-	-	-	-

*Order number: 1 = highest, 2 = next highest, etc.

Wisconsin

WINTER IS HIGH RUNOFF TIME AT FENNIMORE

N. E. Minshall, Fennimore.--On a 171-acre watershed, 16 percent of average annual precipitation occurring during the period December through March, caused 60 percent of the average annual surface runoff. Although 84 percent of annual precipitation occurred during the period April 1 through November 30, only 40 percent of annual surface runoff occurred during this period. These averages represent 18 years of record at Fennimore. During this period average annual rainfall was 32.7 inches, the same as the 60-year normal (1895-1954) at Lancaster, Wisconsin. The fact that the major portion of surface runoff occurs during the dormant season is an important consideration in the design of water supply reservoirs.

Wisconsin

BASE FLOW CONSTITUTES MAJOR PORTION OF ANNUAL RUNOFF

N. E. Minshall, Fennimore.--Base flow from a 330-acre watershed was separated from the flow hydrograph for all storms during the 18 years of record. Seasonal base flow varied from 0.60 inches per month in 1944 to zero in 1950 and 1951. Annual base flow varied from a maximum of 5.0 inches in 1944 to a minimum of 0.20 inches in 1950. Average annual base flow was 2.43 inches and accounted for 55 percent of total annual runoff. Analyses, thus far, indicate that the base flow from these small agricultural watersheds is more closely related to precipitation than to any other single factor.

Texas

CONSERVATION PRACTICES REDUCE RUNOFF FOLLOWING DROUGHT

R. W. Baird, Riesel.--Runoff from a conservation farmed watershed was compared with runoff from a nonconservation farmed watershed for the period November 1956 through March 1957. At the beginning of this period both watersheds were extremely dry, regardless of crop or treatment. Land use for the watersheds is shown in Table 1. Conservation treatment of the one watershed included terracing and contouring as well as other management practices.

Table 1.--Major land use on two watersheds, Reisel, Tex.

Land use	Conservation area 132 acres	Ordinary practice area 176 acres
	Percent	*Percent*
Row crop	48.4	59.3
Oats	17.8	19.4
Pasture and meadow	30.8	18.0
Roads	1.2	1.2
Farmsteads and other uses	1.8	2.1

Marked differences appeared in the amount of runoff from the two watersheds. With almost equal rainfall, the watershed farmed with ordinary practices produced more than double the runoff from the conservation farmed watershed, as shown in Table 2.

Table 2.--Daily runoff, November 1956 through March 1957, from two watersheds, Riesel, Tex.

Date	Conservation Area	Ordinary Practice Area
	Inches	*Inches*
November 4	.11	.38
November 6	0	T
February 1	T	.01
February 22-25	.02	.02
March 11	T	.01
March 20-21	.14	.29
March 27-28	.02	.10
March 31	.24	.31
Total runoff	.53	1.12
Total rainfall	16.71	16.59

Virginia

RUNOFF REDUCED BY STRIPCROPPING

J. B. Burford and J. H. Lillard, Blacksburg.--Runoff records from two adjacent watersheds at Blacksburg, show marked differences between contour stripcropping and straight row cropping practices. These data are summarized in the accompanying table.

Summary of runoff from the Blacksburg, Va. W-II and W-III Watersheds, 1939-42

Year	Water-shed*	Total Precipi-tation	Total runoff	Runoff as % of Pre-cipitation	Cropping and practice
		Inches	*Inches*	*Percent*	
1939**.....	W-II	19.50	1.962	10.06	) Corn - straight row
	W-III	19.50	1.410	7.24	) cultivation
1940.....	W-II	39.76	1.546	3.89	) Wheat - straight row
	W-III	39.76	0.433	1.09	) seeding
1941.....	W-II	28.43	-0-	-0-	) Clover
	W-III	28.43	0.005	0.02	)
1942.....	W-II	34.53	2.554	7.40	) Corn - straight row
	W-III	34.53	2.935	8.50	) cultivation
Ave. for 3 yrs. of straight row cultivation	W-II	34.24	1.367	3.99	
	W-III	34.24	1.124	3.28	
1943.....	W-II	37.43	2.641	6.91	) Transition period from straight row cultivation to strip cropping - corn and small grain
	W-III	37.43	1.599	4.27	
1944.....	W-II	35.24	0.505	1.35	)
	W-III	35.24	0.325	0.92	)
1945.....	W-II	39.36	0.025	0.06	)
	W-III	39.36	0.017	0.04	)
1946.....	W-II	33.80	0.173	0.51	) Contour stripcropping
	W-III	33.80	0.044	0.13	) using alternate strips
1947.....	W-II	41.82	0.138	0.33	) of corn, small grain
	W-III	41.82	0.326	0.78	) and clover in 3-year
1948.....	W-II	49.00	0.167	0.34	) rotation
	W-III	49.00	0.548	1.12	)
1949.....	W-II	46.29	0.091	0.20	)
	W-III	46.29	0.548	1.18	)
1950.....	W-II	35.48	0.083	0.23	)
	W-III	35.48	0.130	0.37	)
Ave. for 7 yrs. of contour strip cropping	W-II	40.14	0.169	0.42	
	W-III	40.14	0.277	0.69	

*W-II - Area = 5.44 A.; Slope range = 1 to 10%; Soils = Dunmore Series
W-III - Area = 19.3 A.; Slope range = 1 to 13%; Soils = Dunmore Series
**May through December

Records were begun in 1939 when both watersheds were planted to corn with straight row cultivation. Runoff losses that year were almost 10 percent of the rainfall. During the following three years, 1940-41-42, the areas were planted to wheat, clover, and corn, in that order, using straight row cultivation. The average annual runoff for this complete 3-year rotation amounted to about 1.25 inches or approximately 3.5% of the rainfall.

A contour stripcropping plan for both watersheds was initiated in 1943. During that first year, however, two-thirds of each area was returned to corn and one-third planted to wheat. There were no clover strips. The 1943 runoff data are shown in the table but are not considered representative of either straight row or contour stripcropping conditions.

During the period of 1944-50, both watersheds were contour stripcropped using alternate strips of corn, small grain, and clover in a 3-year rotation. The average annual runoff during this 7-year period amounted to less than 0.25 inches or about one-half percent of the rainfall.

Average annual rainfall during the 1940-42 period of straight row cropping was almost six inches less than during the succeeding contour stripcropping period; but total runoff, expressed as a percentage of total precipitation, was about 6-1/2 times greater under straight row cropping. On the basis of total runoff, without regard to rainfall differences in the two periods, the ratio was 5.5 to 1 in favor of the stripcropping.

SEDIMENTATION

Mississippi

SEDIMENTATION RESEARCH EXPANDED

Russell Woodburn, Oxford.--Beginning July 1, 1956, the Congress provided funds for an intensified program of sedimentation research in the Yazoo-Little Tallahatchie River Basin. The going project at State College is being expanded into a comprehensive research investigation, involving correlated field and laboratory studies of the processes of erosion, entrainment, transportation, and deposition of sediment together with research on the hydrology of agricultural watersheds. The program was expanded to include cooperation with both the Mississippi Agricultural Experiment Station and the University of Mississippi. Headquarters for the expanded project were established on the campus of the University of Mississippi at Oxford.

A portion of Pigeon Roost Creek watershed, in Marshall County, was selected for detailed studies. By December 31, 1956, twelve runoff and sediment load stations, with drainage areas ranging from 114 acres to 117 square miles, were in operation; 15 recording and 15 standard rain gages were installed and engineering surveys to establish bench marks for vertical control in stream profile and cross-section surveys were in progress. An area was selected on lands of the Holly Springs Branch of the Mississippi Agricultural Experiment Station for installation of facilities to collect sediment and hydrologic records from 4 single soil-cover watersheds with areas from 1 to 4 acres in size.

HYDRAULICS

Oklahoma

TWIN BARREL CULVERT CALIBRATED FOR RUNOFF MEASUREMENT

W. O. Ree, Stillwater.--A model of an existing twin barrel culvert was built and tested as a device for measuring runoff. The approach topography and gage-well details were also carefully modeled. The test results were compared with a predicted rating based on previous, generalized studies. Differences of as much as 20 percent were found between the predicted and the actual flows. Differences were expected, but the magnitude of the differences was surprisingly large.

The reasons for the discrepancy of the estimate appear to be threefold: (1) the relatively high approach velocity, (2) the position of the gage-well intake, and (3) the estimate for the twin barrel culvert was based on a doubling of the estimated capacity of a single barrel culvert. The various effects cannot be separated without additional study, but it is suspected that the first item is the most important.

Oklahoma

RATE MEASURING FLUME FOR SOUTHWEST HYDROLOGIC PROJECT TESTED

W. O. Ree, Stillwater.--Measuring the flashy, sand laden flows in the arroyos of the Southwest presents several problems. Contracted sections are needed to produce the control, but then the head must be measured in the narrow portion which remains free from deposition. A V-shape is needed to give the required precision of measurement for the low flows. Finally, the approach to the measuring throat must be shaped to avoid undesirable wavers at the measuring section. A flume was designed to meet these requirements, and a model built and tried in the test basin. The tests indicated that the design was satisfactory, but that the performance of the flume could be improved by minor changes.

The second part of the problem, that is, protecting the flume from the scour downstream, is now under study. A stilling basin without vertical blocks or sills is being tried. The flow contains boulders and there is some concern for the possibility of "ball-mill action" by the boulders remaining in the stilling basin causing its destruction; therefore, a self-cleaning type is being tried.

Nebraska

SIMPLE DEVICE DEVELOPED FOR MEASURING FLOW FROM GATED PIPE

N. P. Swanson, Lincoln.--A convenient, inexpensive device for measuring flow of water from gated pipe has performed satisfactorily in preliminary calibration tests. Irrigators using gated pipe for the delivery of water to irrigation furrows usually do not obtain uniform furrow streams nor do they know the actual flows of the streams or the total delivery of water. Researchers usually use calibrated containers and a stop watch or some other specifically designed tool for accurate water measurements. Farmers do not have such equipment and are undoubtedly reluctant to spend the necessary time required to obtain such measurements on a number of furrow streams.

Small, sharp-edged rectangular weirs were installed in the sides of cut-down five-quart oil cans. Crest lengths 0.50, 0.75, and 1.00 inch were used. The weirs were made from heavy gauge sheet iron and were soldered into the sides of the cans which had been cut down to a 4-inch height. The head scales were marked with a file to the sides of the weir notch in hundredths of a foot with even digits on the right and odd digits on the left similar to the system often used on stadia boards. The bottom of each rectangular notch was about 0.5 inch above the can bottom. Turbulence required the use of a baffle. A plate on a plane intersecting the plane of the bottom at the rear of the can was found to be quite satisfactory. The back of the baffle plate is held above the bottom of the can by means of stove bolts. This baffle and the weir are pictured in Figure 1. Details for construction are available from author.

The weirs were calibrated in the laboratory. A typical flow is shown in Figure 2. The Francis formula was used to approximate the capacity of the weirs for design purposes. Somewhat higher discharges were obtained with the constructed weirs. This difference is undoubtedly due to the lower head values as determined from readings on the discharge side of the weir, a velocity of approach, and other uncorrected factors. Any one weir when calibrated, will however, provide accurate stream measurements if the can is held so that sides of the rectangular notch are reasonably near to vertical. Typical rating curves for cans with weirs of various crest length are shown in Figure 3.

Figure 1.--View of can with sharp-edged rectangular weir, baffle removed.

Figure 2.--Calibrating can with sharp-edged rectangular weir in Hydraulics Laboratory, Agriculatural Engineering Department, University of Nebraska.

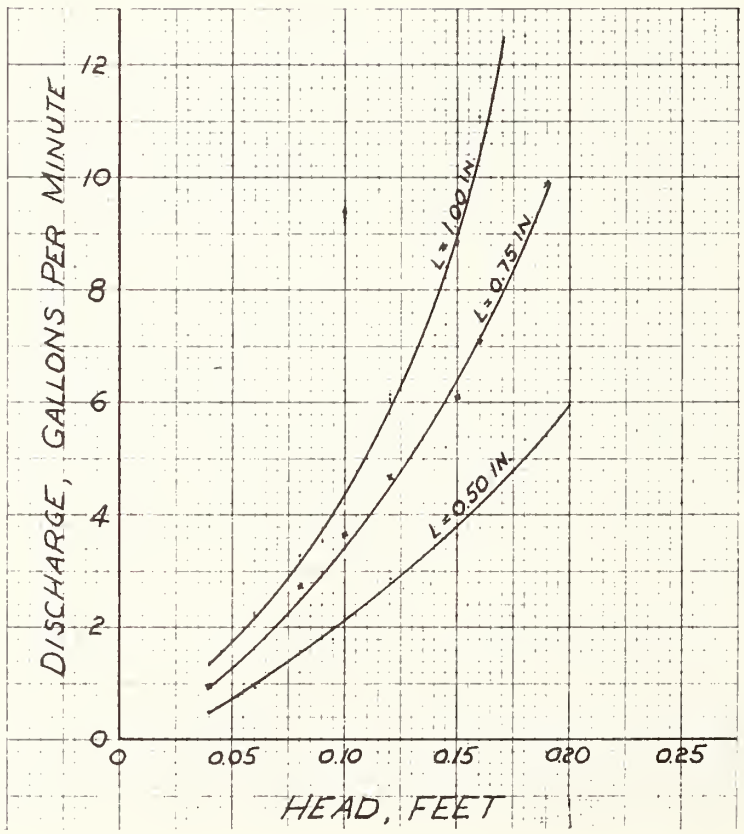


Figure 3.--Rating curves for cans with rectangular weirs of various crest lengths, Lincoln, Neb.

It is recommended that each weir constructed be individually calibrated. This can be done for small streams with a garden hose, stopwatch, and a container of known volume.

Colorado

VORTEX TUBE SAND TRAP TESTED IN LABORATORY

A. R. Robinson, Fort Collins.--A test section containing a vortex tube was constructed and tested using a large flume and a recirculating sediment system as shown in Figure 1. The shape and size of the tube was determined using past experiments as a basis of design. Measurements were made of quantity of flow in the channel and tube, and of the total sediment load and the amount removed by the tube.

The efficiency of sediment removal for different size fractions as well as an overall efficiency for the total load are shown in Figure 2. The range of velocities and depths covered the normal range encountered in the field as indicated by the Froude number varying from 0.4 to 1.4.

Generally, the efficiency of trapping was very good for the coarser fractions of materials. For the range of material sizes greater than 0.295 mm. (0.012 inches) an efficiency of trapping of approximately 80 percent is indicated. As would be expected the efficiency in trapping the finer fraction, in this case less than 0.295 mm., is much lower than with the coarser material. Even for this material some trapping was accomplished over and above the percentage of water which was removed by the tube. The water removed by the tube varied from 10 to 19 percent of that flowing in the channel.

Minnesota

TRAINING GIVEN IN HYDRAULICS OF SOIL CONSERVATION STRUCTURES

Fred W. Blaisdell, Minneapolis.--Training courses for engineers, in the hydraulics of soil and water conservation structures were conducted at Grenada, Mississippi, and at the St. Anthony Falls Hydraulic Laboratory. Subjects treated in these technical training schools or short courses included the following:

Closed conduit spillways
Open channel flow phenomena
Straight drop spillway stilling basin
Box inlet drop spillway--capacity and outlet design
SAF stilling basin
Supercritical flow in open channels
Principles of sediment transportation
Agricultural drain tile--quality and junctions

The portable demonstration channel shown in the accompanying photograph was used in Mississippi. Various models were placed in the channel to illustrate the hydraulic performance of good and poor structures. The experience of seeing a structure in operation is a major aid in training. The channel was used in conjunction with lectures, movies, and problems. Two types of training and demonstration were presented. Technical training for engineers requires about four days of intensive work for satisfactory presentation. General training and demonstrations for nonengineers requires two to three hours. The general demonstrations in Mississippi were presented to the Area Conservationists and other technicians of SCS to acquaint them with the hydraulics of soil and water conservation structures, to State Highway Department engineers, and engineers from other agencies interested in the demonstrations, and to the students from engineering schools.

Training schools were also held at the St. Anthony Falls Hydraulic Laboratory. These schools run for a full week and the training is intensive. Attendance is limited to 15 to 20 engineers to permit individual attention.

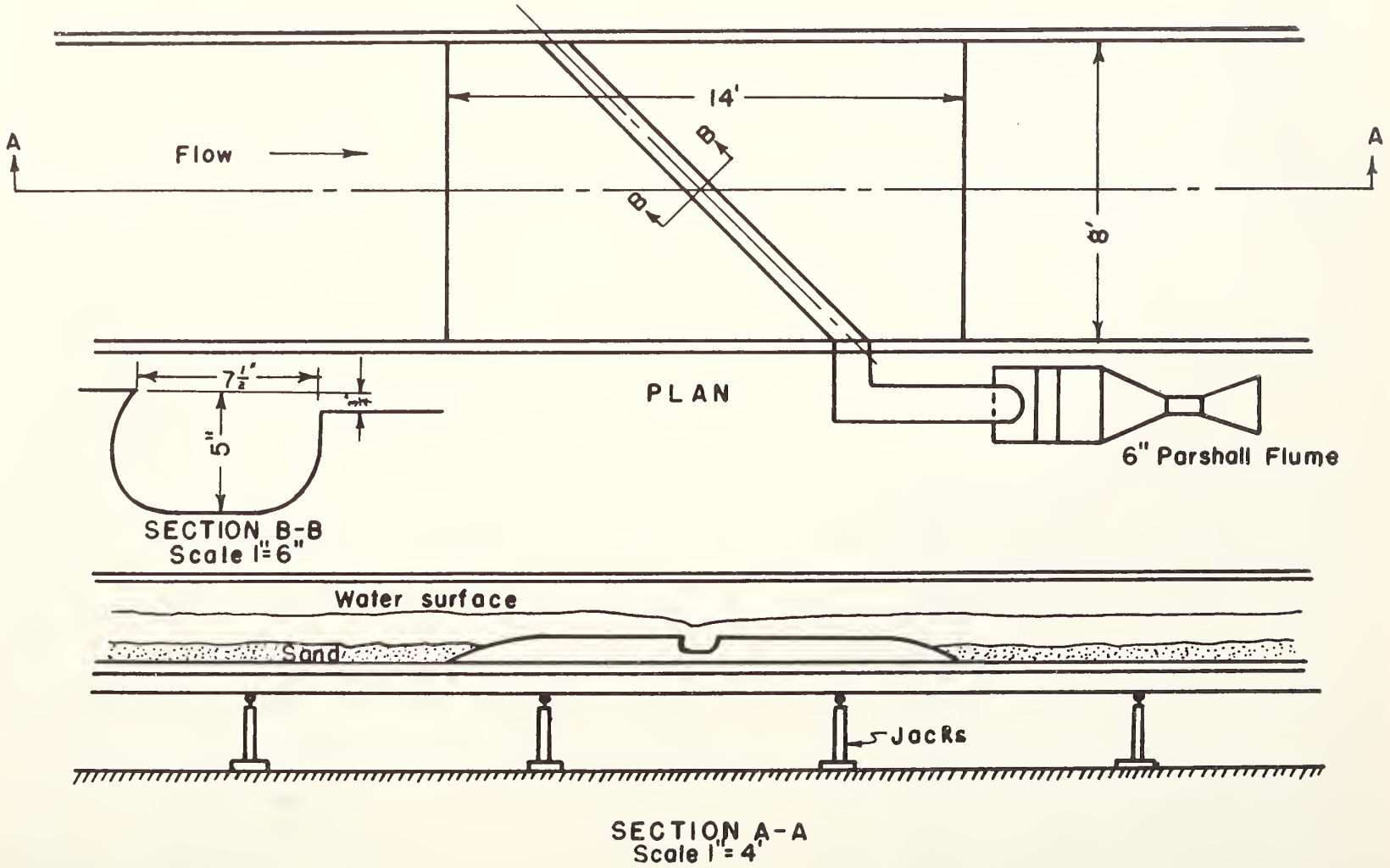
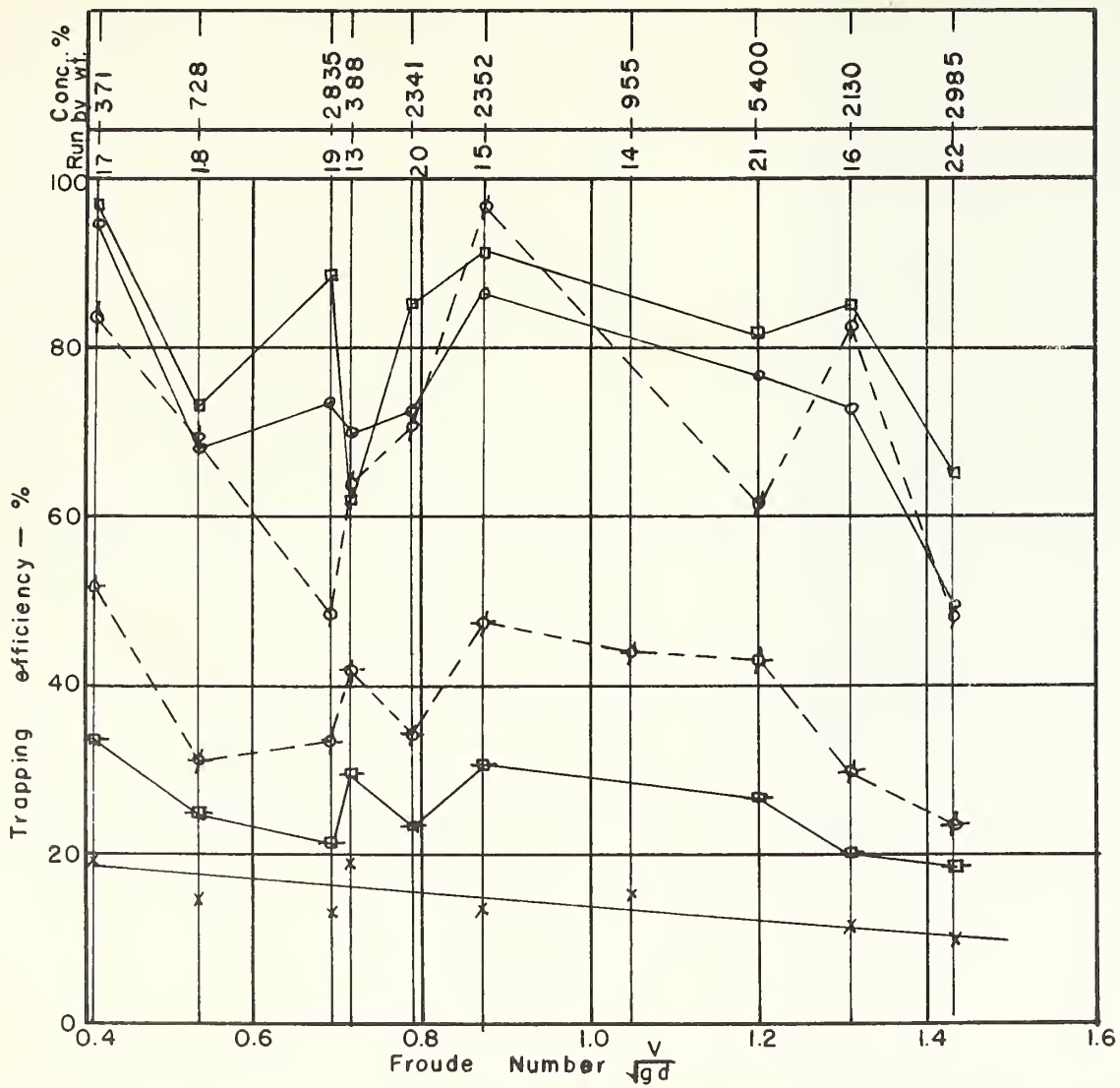


Figure 1.--Layout of vortex tube sand trap.

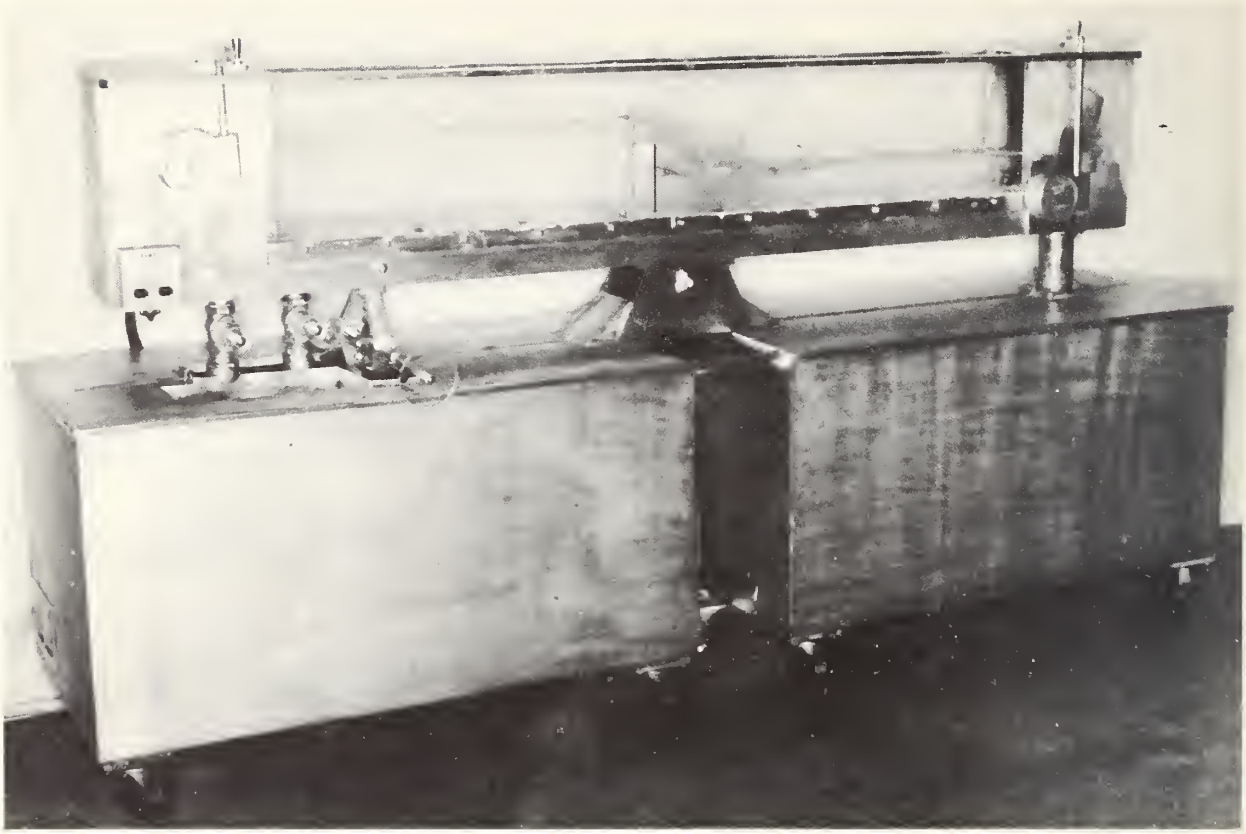


LEGEND

- Totol efficiency
- x Ratio of woter removed to totol flow
- □ Greoter thon 0.833mm.
- o 0.589 – 0.833mm.
- ◇ 0.295 – 0.589mm.
- ⊏ Less thon 0.295mm.

Run No	Deposits in Tube
12	Deposits in middle half.
13	Smoll deposits full length.
14	Tube cleon.
15	Smoll deposits full length Partly full 1/3, 1/2, 2/3 points
16	Tube cleon
17	Deposits middle 2/3.
18	Deposits end 2/3. Cowoy from outlet.
19	Deposits middle 2/3.
20	Deposits ot 1/3 + 2/3 points.
21	Tube 5/8 full 3/4 of length from closed end.
22	Tube cleon.

Figure 2.--Trapping efficiency of the vortex tube sand trap.



Portable hydraulic demonstration channel.
Model being demonstrated is a straight drop spillway and its stilling basin.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Division are listed below.

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